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THE

UNIVERSAL ELECTRICAL DIRECTORY

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QUACKERY IN ENGINEERING EDUCATION.

IN a recent number of the *Engineering Magazine*, a Mr. Kidwell fell foul of Prof. Thurston, who in a previous article had, he thought, claimed far too much for the technical schools. What particularly rouses his wrath is Mr. Thurston's claim for the student that the equivalent of a few days' work makes a good smith of him, and that he soon learns enough in the foundry to be unable to find a pattern he cannot handle, and so on, Prof. Thurston glorifying that arena in life in which he gains his living. Mr. Kidwell evidently thinks the whole business of technical colleges a fraud, especially as regards the experimentation with $10,000 engines where a $700 engine would teach as much, and that $1,000,000 is only enough to just make a start for a technical school. Indeed, he smites the Professor hip and thigh, and, himself a technical teacher, disclaims the possibility of doing more than to inculcate the principles of engineering, and to familiarise the student with the practical application of such principles only to a degree which in a school must be decidedly limited. He is also specially severe on the practising professor, who cannot, he says, earn large sums in conducting tests and doing a lot of work, and at the same time do his duty by his students, who are passed off with lectures out of an ancient note book.

Worse still is the professor who uses his students as assistants in the work of testing. Of course, it is exceedingly nice for a practising professor who has to test an engine to be able to lay on a round dozen of fairly educated students to read thermometers and take diagrams at frequent intervals, and possibly a little of this sort of thing does no harm to the student, even if the fee all goes to the professor; but it is perhaps a little galling to the common or garden engineer, who must keep on the *qui vive* himself a whole day, and take diagrams and readings and coal weighings, and all that sort of thing, without a college fund to back him up.

Following up the question in the June issue, Mr. E. H. Williams, jun., finds fault with Mr. Kidwell. He deprecates any attempt on the part of the student to become a skilled mechanic. To do so would take too long: the student might become a mechanic, but he would fail to become an engineer. This latter kind of critic is as bad as the Kidwellian variety, for these writers on technical education overlook too much for their opinions to have any value. In most cases, probably, the engineering student is either comparatively poor in money or runs the chance of having chosen a father who may become so. He is likely to be placed in many a tight corner before he establishes his position. Engineers who have "graduated," to use the American term so freely applied to technical students, *via* a spell of colonial life, will agree that, no matter what may be a man's qualifications, he is often compelled to undertake work which has never been provided for in any

college curriculum, or been in view of a hopeful parent when he paid his big premium. Whitewashing, for example. Where is the college professor who holds the chair of whitewashing, or he who teaches the mysteries of the shovel? We have seen in a distant colony an engineer expounding the mysteries of a sewing machine 50 times a day. We have been charmed by the musical performance of a son of one of the best known publishers in England, who found it necessary to eke out in this way what his profession of engineer denied to him. Yet these technical school men talk about the waste of time spent on music or the classics. But who ever met a man in the struggling stage of life who was not a better companion for his classics and his music, and who was not the better able to emerge from the depths and re-enter his proper sphere when the opportunity offered? Where one man would teach manual work Mr. Williams would almost shun it. We think both are wrong.

It is not desirable for the student to acquire real skill in every branch—pattern making, fitting, the turning shop, the smithy, and the foundry; but he would certainly do well to acquire a certain proficiency in one such branch. It may mean to him the difference between a day labourer's place and pay, and double that pay to be able to take a place as a carpenter or as a smith. It has been aptly said that a man should know something of everything, and everything of something, and so far as it can be managed, there is no better advice. Mr. Williams despises the frittering away of time on learning manual labour that the student will, under no circumstances, put into practice in after life. This is nonsense. Why under no circumstances? Can life be laid out as if paternal misfortunes did not occur?

Mr. Jackson rightly condemns the proposition that the schools should be expected to turn out finished engineers. This is truly an absurd expectation. He recommends as a test of the value of engineering schools that the students of 15 or 20 years back should be traced out, and their present positions noted.

Mr. H. K. Landis writes of the mining schools, which he describes as tossing their poor graduates among the bunco men, mining sharks, silver-tongued speculators, and shrewd business men, to sink or swim, as chance may direct. Mr. Howe sticks up for the $10,000 engines for teaching the theory and practice of jackets and compounding, and thinks great disadvantage would attend the use of a $700 engine for the purpose. He also upholds the practising professor, and considers a well-equipped laboratory for tests is a good thing to be at hand in the midst of any manufacturing community. He thinks the professor ought to keep in touch with practice, and so on. For our own part, we should like to see the old apprentice system revived, even if modified. To read the list of subjects supposed to be "taught" by some technical colleges is simply appalling. No engineer has the knowledge—no student can master the heap. No single professor can teach the lot, yet the whole dish is to be swallowed by the student. We are much inclined to think there will be a return to a more old-fashioned and classic style of scholastic education, followed by evening study at a merely technical school, and daily work in a practical business establishment. The writings of the technical educators themselves are not hopeful as aids to a solution of the question; the professors are so hopelessly at variance. Technical schools ought not, however, to be expected to effect so much, and there can be no doubt that the right kind of student will extract from them much that is valuable, while other students gain simply nothing.

A NATIONAL SUBMARINE TELEGRAPH MEMORIAL.

We can see no objection to the shareholders and employés of a vast monopolistic submarine trust—a trust entirely in the interests of the shareholders—making contribution towards a memorial to commemorate its founder.

We do not yield to anybody our respect for his sagacity and far-seeing shrewdness, but we cannot see why a national monument should be erected to the successful financier of cables any more than to the successful man of any other trade.

To the pure scientist, whose modesty often leads him to be relegated to a back street, while the pushing money-maker takes all that comes along, any monument would be appropriate. To such men as Lord Kelvin no recognition whatever can be too great, but we must confess that our contemporary, the *Electrician*, gives us no other option than to contend against the collection for a memorial outside the "Eastern" group of cable workers, makers, and dividend earners.

The upward movement of submarine cable communication was dependent upon no single man, neither has its consolidation been made in this manner. Its progress has been step by step, and although it has been built by many hands it has been got to almost a common centre. The federation of the world will not be brought about by submarine cables; it is idle to think this. The confederation of the Colonies with this Empire is, however, a different matter. Here there are interests in common, the same blood, language and history! but it is the one who gave his great ability towards rendering any such movement abortive for whom a national monument is asked.

Our contemporary is again singularly unfortunate in its references to the past. We think there is no question as to the utility of telegraphic communication; work could not be transacted otherwise with that facility which rapid immediate transmission of thought gives. We could not do without railways, steamships, and hundreds of other things; but when we hear of the effect of modern newspaper expectations, and of the time long gone by when meagre belated accounts reached editors, we are at once transported to the horror of a possible second visit of the Secretary of State for the Colonies to the City in search of African telegrams. Whose turn will it be next?

We agree with our contemporary that submarine telegraphy will assist Imperial Federation, but it must be carried out in a different manner than as at present. Colonies must be bound to colonies over entirely British soil. Those who object to this, in our mind, and those who attempt to decentralise that which is said by our contemporary to be one of the factors vital to this nation's greatness, viz., the need of keeping this great city of ours as the centre of the international system, will not do much which will be of utility to their country. It may be profitable to themselves or to individual interests.

TRACTION DIAGRAMS.

By THOMAS TOMLINSON, B.E.

(*Continued from page* 101.)

Stops and starts. First we have to consider the time or distance within which a tramcar can be brought to full speed from rest.

The late Mr. A. Reckenzaun gave 20 seconds. "From numerous experiments, I have found that it takes about 20 seconds to bring a tramcar from rest to its normal speed." *Journal* Inst. Electrical Engineers, Vol. xxi. This, I find, is about the time taken on the District Railway; the traction diagrams of the City and South London Electric Railway show 20 to 40 seconds, Electrical Review, August 12th, 1892.

150 feet, and the drawbar pull per ton necessary to give required acceleration in given time is

$$\frac{2{,}240 \times 15^2}{2g \times 150'} = 52{\cdot}5 \text{ lbs.}$$

$$\text{(taking } \frac{2{,}240}{2g} = 35 \text{ approximately).}$$

The number of stops on a tram line per mile varies very widely, of course, according to the amount of traffic, "from four to eight stops per mile on English tramways," and the stops are not likely to be distributed at equal intervals over the length of the line; for purposes of illustration, however, we may take, on our length of 15,171 feet (3 miles, say) 13 stops, *i.e.*, a little over four a mile and these at equal intervals. Here again actual running diagrams remove all doubt for the particular line to which they refer.

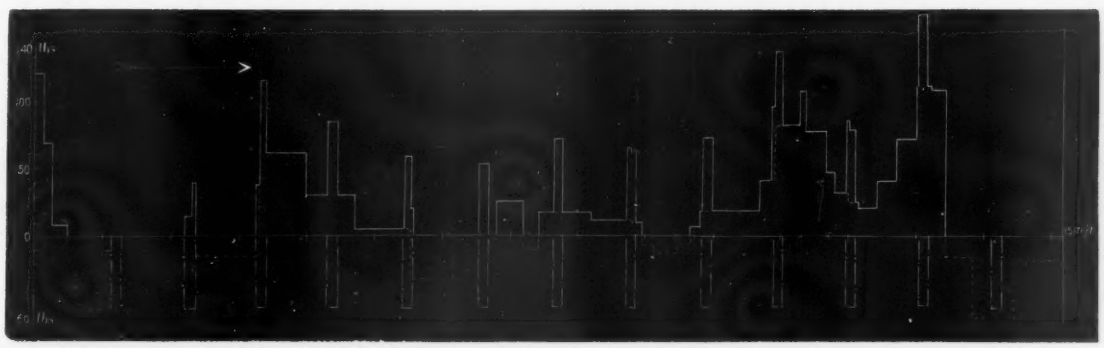


Fig. 5.

As quick starting is extremely desirable, we may provisionally assume 20 seconds as the time necessary. For the stopping we may take 10 seconds provisionally; the traction diagrams of the City and South London Railway, above alluded to, show about this time.

Of course, in connection with the traction diagram of a given run there is no difficulty, the lengths of run taken up in stopping and coming to full speed again will be shown.

On the supposition, then, of 13 stops and a drawbar pull for acceleration of 52·5 lbs. per ton, we can construct from diagrams 3 and 4 diagrams 5 and 6, in which we first plot, below the base lines, the rectangles showing the drawbar pull to give acceleration, and then add to the figure giving drawbar pulls as due to friction and grade combined, as much of these rectangles as lie outside the figure giving drawbar pulls wasted due to excessive grade, which are thus partially utilised.

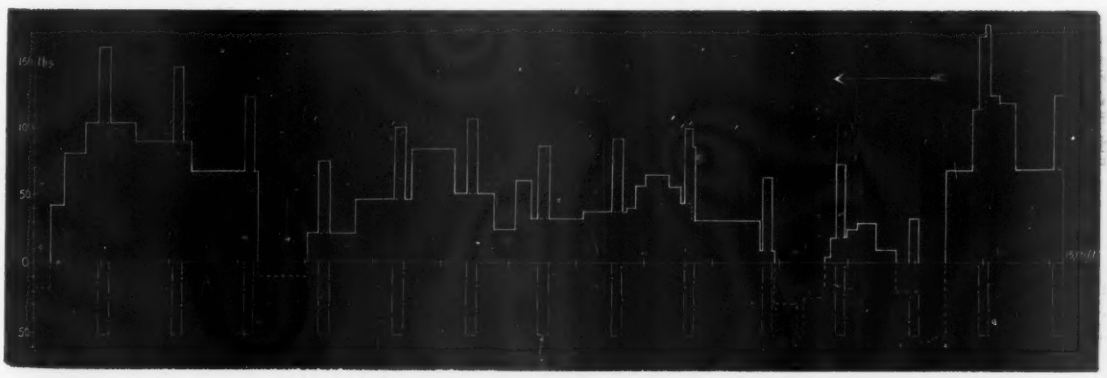


Fig. 6.

As to the actual time of the stop—this only affects the diagram (when plotted to a base of lengths along the line) in so far as to keep time, long stops mean higher running speed.

I should think in tramway work the stoppages are of extremely short duration; so short as to have no appreciable effect, for a first approximation, at any rate. The traction diagrams of the City and South London make the duration from five to 40 seconds; but this is for a train, with fixed stopping places, taking up and setting down a number of passengers.

Taking, now, the full speed to be 15 feet per second (10 miles per hour, say), the average speed from rest to full speed is 7·5 feet per second; the length passed over in 20 seconds is

That is to say, acceleration costs more in power on the average on a perfectly level line than on a graded line.

Now, with regard to the figures (5 and 6) so obtained, this is to be noted: They show the drawbar pull necessary to produce acceleration as a steady pull applied throughout the whole time of acceleration, and there is no attempt to show the initial pull to overcome the resistance at the instant of starting.

With regard to the initial pull, this is properly not represented; because as it is instantaneous, and the speed is nothing at the time, it represents no power, and our object in plotting the drawbar pulls is to get at the power curve by combination of the drawbar pull diagram with the speed curve.

With regard to the representation of accelerating force as a constant drawbar pull throughout the whole period of acceleration: this is not the way in which an electromotor or motors would naturally accelerate a car, but it is the most efficient way, and we are therefore entitled to take it as the true expression of the force theoretically required to start and accelerate a tramcar.

It is worth while noting that this ideal starting is effected by the steam locomotive, in which the initial torque is given by the initial pressure in the cylinders (involving no power); the mean running torque is given by the mean pressure in the cylinders, and is constant over the period of acceleration, power being automatically proportioned to speed of advance by increase in number of strokes.

The laws governing the electromotor which prevent it starting a car in this way are much against it as a starting gear, and necessitate the adoption of various starting devices, so as to reduce the initial demand upon the source of supply, the excess of which demand, it should be remembered, is due to this defect of the motor, and not to the mechanical necessities of the start.

Another point about the diagrams (figs. 5 and 6) may be noted here. They are plotted as if for a constant speed between the points at which full speed is attained after the starts, and the points at which current is taken off before the stops; if the speed varies between these points, then the drawbar pulls will be increased or diminished, in accordance with the decrease or increase of the speed, and these allowances must be made before multiplying by speed to get power curve. This is the way in which, in practice, the fly-wheel action of the moving car compensates for the power not being at all times proportional to the demands of the line for constant speed. The more, however, nearly the speed is kept constant, the better for economy—*i.e.*, the better the driver knows his line and uses his knowledge, the more cheaply will he run his car.

In investigating generally the power required upon a tram line; as apart from the drawing of the actual theoretical traction diagram, to correspond with and be comparable point for point with an actual running diagram; or to arrive at the mean value of the increased power demanded by a certain number of stops and starts, it will be more convenient and more accurate to find the allowance in general terms, and not from such a particular construction as is shown in figs. 5 and 6.

For this purpose it is only necessary (see fig. 7), having drawn the lines, A B and C D, as in fig. 2, at distances, L A, and L D, above and below L M, equal to the average value of p, to draw two other lines, N O, below A B, and P Q, above C D, at distances, A N, and D Q, equal to the value of the drawbar pull in pounds per ton necessary for acceleration from rest to the required running speed (52·5 lbs. in our case), and to compute the mean drawbar pull required for acceleration over the line by taking the areas of A B O N, and C D Q P, less the areas of the part of the diagram for grade included in them, which represents the waste drawbar pull due to excessive grades, and which is utilised in starting.

In our case the areas of the rectangles are each 15,171 × 52·5 = 796,477 foot-pounds, whilst the areas of the parts of the grade diagram to be subtracted are:—

For a journey left to right, 185,341 foot-pounds.
For a journey right to left, 116,469 foot-pounds.

Leaving the respective mean average drawbar pulls in pounds per ton necessary for acceleration to 15 feet per second in 20 seconds.

For a journey left to right

$$= \frac{796,477 - 185,341}{15,171} = 40{\cdot}2 \text{ lbs.}$$

For a journey right to left

$$= \frac{796,477 - 116,469}{15,171} = 44{\cdot}8 \text{ lbs.}$$

So that the mean average drawbar pull for required acceleration is 42·5 lbs. per ton.

This is (as it should be) equal to the difference between the drawbar pull for acceleration on the level (52·5 lbs. per ton), and the allowance for unutilised grades (10·0 lbs. per ton), which we added to the drawbar pull per ton on level (25 lbs. per ton), to get the combined drawbar pull for friction and grade (35 lbs. per ton), because in each case we subtract or add the same quantities, viz, the mean drawbar pull due to excessive grades unutilised, represented by the areas of the dotted parts of the grade diagram shown in figs. 5 and 6.

From this mean value of drawbar pull necessary for acceleration, we can deduce the value of the added mean drawbar pull for acceleration for 14 starts (allowing for initial start). It is

$$\frac{14 \times 150' \times 42{\cdot}5}{15,171'} = 5{\cdot}8 \text{ lbs. per ton.}$$

This agrees nearly with the result (5·75 lbs. per ton) which results from fig. 5, but is much lower than the result (7·07 lbs. per ton) from fig. 6; but it will be seen that in fig. 6 the starts have nearly all occurred on up grades or levels, and so are are not average, inasmuch as the down grades are quite unutilised.

We cannot add this mean drawbar pull of 5·8 lbs. per ton to the mean drawbar pull (35 lbs. per ton) already obtained for combined friction and grade for steady running, without allowing for the reduction of the latter by the utilisation of part of the energy of the moving car before stops in running the car from the time current is cut off till the car stops (75 feet); the value of this for 14 stops, taking 35 lbs. per ton as mean value of drawbar pull to move car is

$$\frac{14 \times 75' \times 35}{15,171} = 2{\cdot}4 \text{ lbs. per ton.}$$

The mean added drawbar pull per ton due to 14 stops and starts (counting initial start and final stop as one) is therefore 5·8 − 2·4 = 3·4 lbs. per ton.

In general terms the mean added drawbar pull for each stop and start is

$$\frac{s \times \text{mean drawbar pull to accelerate} - s_1 \times \text{mean drawbar pull to run}}{\text{total length of line.}}$$

Where s = distance over which acceleration takes place, and s_1 = distance over which retardation takes place.

The loss in unutilised energy of the car on stopping, which must be taken by the brakes, is evidently given by the same expression in the form of mean drawbar pull wasted. Here again, then, waste is represented by an increase in mean drawbar pull just as the waste of unutilised grades is represented.

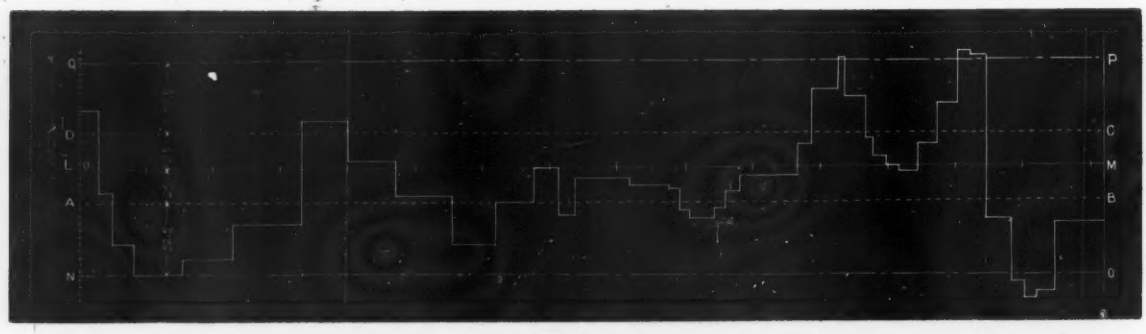


Fig. 7.

The total mean drawbar pull on the tram line we are considering is then made up so:—

25	lbs. per ton	(65	per cent.)	due to friction.
10	„	„	(26	„	)	„ grades.
3·4	„	„	(9	„	)	„ acceleration.

Total = 38·4 lbs. per ton.

The noticeable point is the comparative smallness of the direct effect of starts in added drawbar pull.

(To be continued.)

NOTES ON OBTAINING DATA FOR TRACTION DIAGRAMS.

By THOMAS TOMLINSON, B.E.

To be read in connection with Articles appearing in Electrical Review, *July 10th*, 1896, *et seq.*

The idea underlying the articles in the use of the surface length of the line as base, instead of the horizontal datum line, and the resolution of the forces in a direction parallel to this surface line from point to point.

What is required to get the full advantage of the comparison of the power required with that expended, is :—

1. Section and plan of line so detailed that the beginning and end of all curves and grades, and the radii of the former, and rise or fall of the latter are clearly marked ; a constructive plan and section in fact.

From these a diagram (as in fig. 2, Electrical Review, July 17th, 1896) can be constructed by calculation of surface lengths from lengths along datum line and grades.

Failing such plan and section, use the mechanical plan described in Electrical Review, July 10th, 1896.

2. A speed counter on an axle (which must never be dead braked, with distance posts or marks every 1,000 yards (measured along the surface), against which to check the readings of the counter, so as to guard against a small cumulative error becoming serious.

3. A speed indicator on the same axle, reading to feet per second of advance of the car (or easily reducible to that), and as sensitive as possible, *i.e.*, geared high.

4. Readings of ammeter, voltmeter, speed indicator, and counter—the readings to be taken when entering and leaving a curve, and when current is shut off for a stop and when full speed is attained after a start. In fact, generally readings when marked changes occur in any of the things recorded.

If you want to separate out loss due to resistance, use two voltmeters.

5. Readings of counter and indicator with current off and brakes not used upon one or more down grades at or near that for which p (average) = 2,240 tan θ, so as to get the value of p for the run.

6. Weight of car or cars (and locomotive if any) and number of passengers from point to point.

7. If on a street tramway with sharp curves and no superelevation of rail—records of a run over the line *at the average speed at which the curves are taken*—see Electrical Review, July 17th, 1896. On this run there should be no stops, and it should be run on the speed indicator, *i.e.*, at constant or nearly constant speed.

SILK-COVERED WIRE TESTING.

The practice of submitting all materials to test before they are accepted from the supplier has a two-fold advantage; it ensures that bad material is rejected, and it also results in the gradual improvement of the manufacture of the material. A manufactured article is tendered for to meet a particular requirement, and it is found that a portion of the bulk is very much above the specification; the inference is that, with proper precautions, the whole of the bulk could have been made equally good, and the specification is modified accordingly, to the disgust of the manufacturers, who declare that it is impossible to work to the terms. After a time this assertion is modified into the statement that the conditions can be complied with, though there will be great difficulty in doing so. Finally, a third stage is reached, in which the manufacturers, having set their wits to work, find that what was impossible can be done without difficulty.

The state of perfection to which the manufacture of silk-covered copper wire has been brought has largely been due to a determination that every point in connection with the same shall be as near perfection as possible. The highest conductivity is insisted upon, and the thinnest possible covering, consistent with safety, is demanded. The amount of wire annually consumed is not at all insignificant, and the rapid testing of samples is a by no means unimportant matter. The apparatus which we illustrate is one designed and used by the Postal Telegraph Department for the purpose of testing the conductivity of the copper and the thickness of the silk covering, of the numerous consignments which are annually received.

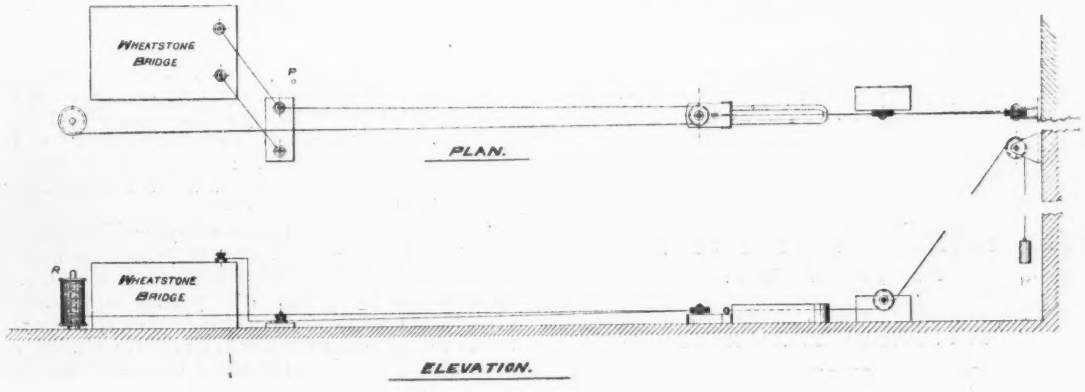


Fig. 1.

The following is the *modus operandi* :—

To pay out the wire, and measure the resistance, the reel to be tested (R, fig. 1) is placed on a pin in the table; the end of the wire is bared and fastened to the back terminal of the pair on the table; the wire is then passed round the wheel of the carrier (which is held ready to hand by the pin, P) and the carrier let go, and the reel turned to pay out the wire. When the carrier reaches the magnet, it is held there by its tin-plate end; the wire is drawn tight at the reel, and having been bared opposite the front terminal, is connected up, without being severed. The magnet is fixed by two pins to the bench at such a distance that there is now the length of wire required between the two terminals, which are joined directly to those of the Wheatstone bridge. The resistance having been taken, the front terminal is undone, the carrier released from the magnet, and the wire rewound on the reel. The carrier, drawn back to the bridges by the re-winding, is placed again on the pin, P, ready for the next resistance test. The weight, W, is varied to suit the gauge of the wire.

To measure the total diameter, the reel is placed on a suitably arranged pin, so that it will turn freely, the end of the wire is fastened to the gauging machine (fig. 2) by winding it several times round the screw, S, and the pointer having been placed at O, the wire is wound on the cone until one or more of the $\frac{1}{4}$-inch spaces have been filled ($\frac{1}{4}$ inch being sufficient for the smallest sizes of wire); then the average diameter will equal the length in mils. covered, divided by the number of turns shown by the pointer. To leave the machine ready for the next test, the pointer (which does not move with the wheel), is turned to zero by means of the milled head, H, the conical reel pulled off the squared part of the axle, so that it will turn freely for the wire to be pulled

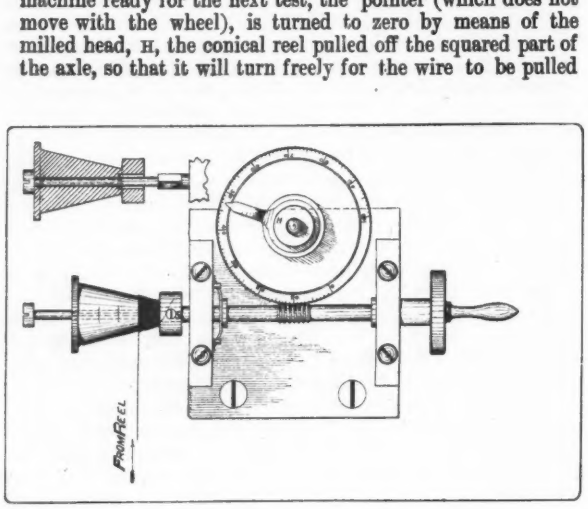


Fig. 2.—Wire Gauging Apparatus.

off; which done, the reel is pushed back on to the square. The reel is made conical, so that the wire can be closely wound without trouble.

The insulation of the wire can be tested whilst the wire is on the cone.

The method has made a rather long and tedious operation, short and agreeable. Tests of the same sample of thinnest wire can be repeated any number of times without difficulty, a result not practicable before.

THE CHEMICAL THEORY OF LEAD ACCUMULATORS.

By DESMOND G. FITZ-GERALD.

In the New York *Electrical World*, a series of articles under this heading, by Mr. Maurice Barnett, has just been completed. These papers, which discuss, if they do not carry into effect, the application to lead secondary batteries of one of the most important generalisations of modern science, are no doubt of interest to a large class of electricians. Their gist, however, appears to me to be contained within what a lawyer might term the "four corners" of the papers published by Mr. E. J. Wade in the columns of a London contemporary towards the end of 1894. Moreover, Mr. Barnett does not exhibit the same degree of care and accuracy that is shown by Mr. Wade. It is unfortunate, perhaps, that the contribution of this writer to the literature of the secondary battery received inadequate notice, and was not subjected to stringent criticism. From the point of view of the writer himself, the question is left undecided and unnoticed whether to him belongs the credit of having established the theory of "lead accumulators" on a firm basis of thermal chemistry; and, from the point of view of the electrical public, any errors into which Mr. Wade may have fallen remain uncontradicted, to be propagated by subsequent writers like Mr. Barnett.

Of course, it is in the data of thermal chemistry that any error would be of most vital importance; but there may be errors of an historical kind, and other mischievous misconceptions, to be removed before the course is cleared for other competitors. One of these is contained in the very first words of Mr. Barnett's contribution. He says:—"Up to the time of the introduction of the Faure cell, and during the years immediately following, the theory advanced to explain the action of the lead accumulator was, that the oxygen and hydrogen dissociated during charging were occluded at the electrodes—oxygen at the positive and hydrogen at the negative; and that these, on recombining, produced the phenomena of discharge."

The above is, apparently, an amplification of the suggestion, more cautiously worded, of Mr. Wade:—

"Before attempting to decide what are the actual chemical reactions taking place in a lead storage cell, it will be as well to see first what theories have already been advanced, and how they have been evolved. Planté did not pretend to go at all deeply into the chemical causes of the physical effects he obtained. He observed the formation of lead peroxide at the positive electrode, and that the local action set up between it and the metallic lead in immediate contact resulted in the formation of lead sulphate, and, as he thought, the liberation of oxygen, but later research has shown that this is due to other causes. He also noticed the reduction of the peroxide to monoxide or litharge at the positive electrode; the oxidation of the lead at the negative electrode and the formation of films of sulphate on both; but on the whole he seems to have been inclined to ascribe the activity of the cell chiefly to occluded oxygen and hydrogen. During the period immediately following Faure's introduction of plates pasted with oxides, this view seems to have been held almost exclusively. Water, it was argued, was the real electrolyte, sulphuric acid merely being added to increase its conductivity, and, on charging, it was decomposed into its constituent gases, which were liberated and absorbed at their respective electrodes."

Now, I venture to say that this idea of the existence at any time, amongst electricians, of the theory that the action of the lead accumulator is explained by the occlusion of oxygen and hydrogen gases rests upon a very slight foundation of fact. It was considered by many electricians, including myself, that in the electrolytic reduction of lead from its oxide, the metal would almost inevitably become associated with some proportion of hydrogen. But in presence of facts well known and understood, it was impossible to base on this circumstance a general theory of the action of lead secondary batteries. The "Récherches sur l'Electricité" of Gaston Planté was published in 1879; but his first experiments date from 1859. In March, 1863, under the heading "The Student," I wrote as follows:—

"The great power of the secondary combinations we have referred to is due to the presence of peroxide of lead in contact with the negative element in these combinations. This substance, as was pointed out by M. de la Rive, surpasses even nitric acid in its affinity for hydrogen; and for this reason a couple constructed with a negative element of platinum, surrounded by a mixture of dilute sulphuric acid and peroxide of lead, and with a positive element of amalgamated zinc, is more powerful even than the couple of Grove. And when lead instead of platinum is used for the negative element, the power of the couple is but little diminished."*

The rising generation of electricians was here given clearly to understand that, without any possible intervention of occluded oxygen and hydrogen, a primary couple of great power could be constructed on the model of the secondary couple of Planté—zinc being substituted as the oxidisable metal for porous lead. How was it possible, then, that, 16 or 20 years afterwards, anyone knowing what was generally known should ascribe the action of such batteries to occluded oxygen and hydrogen? In 1876-7, my friend, C. A. Faure, was perfectly well aware that the action of Planté's cell was due, mainly if not wholly, to the oxidation, or to the combination with sulphuric radical, of spongy lead, and to the reduction of lead peroxide. In regard to Gaston Planté, is it possible more explicitly to disclaim the supposed occlusion theory than he does in the following:—

"This adherence and this insolubility of the peroxide of lead, together with its affinity for hydrogen, due to its high degree of oxidation, combine to produce, in a voltameter with lead electrodes, a secondary current of greater intensity and of longer duration than that from any other metal. The

* The *Electrician* (Old Series), Vol. iii., March 20th, 1863.

lead coated with peroxide of lead in water acidulated with sulphuric acid behaves in fact in a manner exactly converse to that of zinc. It tends to decompose water by seizing upon its hydrogen, and to become the positive pole of a couple, if it be associated with non-oxidised lead; whereas pure zinc tends to decompose water by seizing upon its oxygen, and becomes the negative pole of a couple which it forms with another metal." In regard to the other element, he says:—

"Under the action of the primary current, the plate of lead at the negative pole does not undergo so marked a change as that of the positive pole; still, as the lead is always more or less oxidised by its exposure to air, it is brought to a more perfect metallic condition by the powerfully reducing action of the hydrogen due to the battery, and its colour changes from a blueish-gray to a whitish gray of a much lighter shade."

I am not aware that Planté anywhere even mentions the occlusion of oxygen and hydrogen gases.

Even in the case of Prof. Oliver J. Lodge, there is no valid evidence that he ever adopted the "occlusion theory," although an unfortunate note of his, appended to the second of the articles he contributed to the *Engineer* in May, 1882, may lend some colour to the imputation. After stating that "the quantities, u and v (gaseous hydrogen and oxygen associated with the plates, either mechanically, as bubbles, or, in the case of the hydrogen, as a sort of alloy), will probably be small," he appends to this statement the note that "They are multiplied by large coefficients though; and I am by no means sure how far it is practicable to neglect them. I believe the reduced lead is alloyed pretty strongly with hydrogen." He neglects u and v nevertheless.

At the present day would anyone state that, in charging an accumulator, sulphuric acid, and not water, is decomposed?

En passant, I must protest against the expression, "a current of 1·5 volts." There is no such thing. Current is a *ratio*, totally independent of the absolute value of either of its terms. It is measured, not by volts, but by the amperes per second traversing any cross section of the conductor.

Mr. Barnett says: "With reference to local action between the active material and the support in the positives, it was thought that this led to the disintegration of the grids." There seems to be here a suggestion that it is no longer thought that local action between the peroxide of lead and its metallic support leads to the disintegration of the latter. "Gladstone and Tribe shared this notion, and believed that the prevention of this was to be found by leaving intact the film of sulphate that covered the grid; and they protested against overcharging, as this reduced the film in question." The expression "little film of sulphate upon the metallic plate, which does not entirely stop, but impedes the local action," was used by Dr. Gladstone in the discussion on my paper on "Reversible Lead Batteries," read before the Society of Telegraph Engineers and Electricians on March 10th, 1887. The original expression in the little work of Messrs. Gladstone and Tribe on "The Chemistry of the Secondary Batteries of Planté and Faure" was "the insoluble sulphate of lead, which clogs up the interstices of the peroxide, and after a while forms an almost impermeable coating of high resistance between it and the first metallic plate," *i.e.*, that supporting the lead peroxide. This expression gave rise to what may have been a misconception, and to a question which were partly, but, perhaps, not thoroughly, thrashed out during the discussion in question. The other expression above quoted is also liable to misconception—has, in fact, given rise to it. Of course, if there were a film of sulphate of lead entirely covering the surface of the support, the resistance of this film would be interposed not only in the local but also in the main circuit. If there were "an almost impermeable coating" entirely interposed between the peroxide and its support—a phenomenon that has occurred in very bad cases of sulphating—there would be no current either in the local or in the main circuit. But what Messrs. Gladstone and Tribe probably meant, having in view the phenomena of the zinc-copper couple was, that if a plate of lead be in contact with particles of peroxide of lead "in myriads of places," and also with dilute sulphuric acid, then the formation of sulphate of lead on those portions of the plate not in contact with the peroxide would impede the progress of the local action by throwing a great resistance into the local circuit, without very sensibly augmenting the resistance to the passage of a current in the main circuit.

"The double sulphating theory of Gladstone and Tribe," says Mr. Barnett, "was not accepted without a protest. The non-conductivity of lead sulphate, and the difficulty of reducing it, made it seem highly improbable that the activity of the cell was due to such a reaction. Experiments carried on both by Lord Kelvin and Dr. Lodge, looking to the reduction of pure lead sulphate with platinum electrodes in sulphuric acid, had not succeeded; and even Gladstone and Tribe had admitted that under such conditions it was only possible to effect a partial reduction after days of electrolytic action. That this reduction should take place instantaneously in the lead accumulator was inexplicable. We shall see later on that this difficulty is explained away by the presence in the electrodes of sulphates with conducting properties."

This "difficulty" is entirely imaginary, and the waste of time over it, when there are questions of real interest to be considered, is one of the vexatious circumstances connected with the present subject of discussion. Here is a piece of "spent" lithanode, *i.e.*, peroxide active material. It is of a light chocolate colour. It is a conductor—of very high resistance certainly, even in comparison with carbon; but not very much higher in resistance than the original lithanode. I wrap a sheet of platinum foil round the top of the strip, attach a binding screw, and make the strip an anode in dilute sulphuric acid. The immersed portion is becoming darker in colour and crystalline, now it evolves oxygen; it is re-charged. Here again is a piece of "spent" spongy-lead plate, made from "lithanode material." Externally it is almost white; where we cut into it with a knife it is bluish-white with some metallic lustre. If we make contact with the exposed surface, we find that the material is a conductor. Making it a cathode, it becomes reduced to the original spongy lead. Now, I take a white—not "dirty white"—powder, viz., sulphate of lead, out of a bottle. When we plunge two electrodes into it, we find that it gives no signs of conductivity. We mix it into a paste with dilute sulphuric acid, which is a good electrolytic conductor; we spread and retain the paste on two platinum plates; and we make these anode and cathode in an electrolyte of dilute sulphuric acid. We observe that, for a considerable period of time, the current apparently ignores the presence of the non-conducting sulphate, which, during that period, is not appreciably acted upon; "*Ergo*," we say, "the reduction (or peroxidation) of the sulphate of lead, undoubtedly present in the samples of 'spent' active material, *is inexplicable*." *Quelle bêtise!*

(*To be continued.*)

ON ALTERNATING CURRENT-RUSHES IN CONDENSERS.

By BERNARD P. SCATTERGOOD, M.A., Oxon.

(*Continued from page* 102.)

19. If we may assume the existence of these high frequency currents, and that their tendency is (as by Lenz's law it certainly must be) to produce the apparent diminution of current observed in the experiment of Sec. 15, the question arises whether they are sufficient to account for the *whole* of the effects observed, or whether we must suppose that the indications of the voltmeter are also, under these abnormal conditions, deceptive. Now, if the effective resistance of the filament of the lamp remains the same on the sparking as on the normal circuit, there seems to be no reason why the intensity with which the filament glows, and the magnitude of the voltmeter deflection, should not, each of them, be a measure of the actual $\sqrt{\text{mean}^2}$ pressure at the lamp terminals, whatever might be the law of variation of that pressure. Conversely, if the judgment of the eye confirms the voltmeter reading, it is to be considered as an indication that the actual voltage at the lamp terminals is what it appears to be. Now, as I have said (Sec. 5), there *is* a fairly close correspondence between the voltmeter reading and the pressure as judged by the glow of the lamp. Hence the voltmeter may be considered as probably indicating the actual $\sqrt{\text{mean}^2}$ pressure at the lamp terminals.

20. The eye, however, is not a very reliable guide in questions of this kind, and it is better to resort to actual measurement in order to determine whether, as is possible on the assumption that the current in the lamp is really oscillating at a very high frequency, a "skin effect" is taking place, whereby the current confines itself entirely to the outer layers of the filament, and thus virtually increases the resistance of the lamp. Clearly, in such a case, it is quite possible that the normal watts might be taken by the lamp, with a terminal pressure *higher*, and a current *less*, than the normal. Thus, if the alternations were sufficiently rapid to increase the effective resistance of the lamp, say, 36 times, a pressure of 600 volts would, in a lamp taking normally ·6 of an ampere at 100 volts, produce a current of only ·1 ampere, while still dissipating energy at the same rate, namely, 60 watts, and producing at least the same amount of light. In consequence of the higher temperature of the filament, the amount of light produced would probably be considerably greater.

21. I made several experiments in order to ascertain whether any such increase of resistance occurs in the filament of the lamp when run on the "sparking" circuit over that which it possesses on a normal circuit; two of these I shall describe. If such a "skin effect" as that spoken of were actually in operation, then for a given $\sqrt{\text{mean}^2}$ pressure at the terminals of the lamp, as measured by an electrostatic voltmeter, the watts expended in the filament should be less on a sparking circuit than when the lamp is supplied with a steady alternating voltage of the same amount under normal conditions. I therefore arranged a calorimetric test, the lamp being wholly immersed in a vessel containing a known quantity of water, in which a thermometer was inserted. A steady pressure of 100 volts alternating was first put on the terminals of the lamp, and readings of the thermometer were taken at intervals of one minute, the results being plotted in a curve; next, the experiment of Sec. 15 was repeated, with this difference, that in place of the lamp previously used, that contained in the calorimeter was put in the circuit. The length of the gap was then adjusted to keep the pressure at the terminals of the lamp, as indicated by the voltmeter, v_0 (see fig. 4), as steadily as possible at 100 volts, and thermometric readings taken as before. These readings were also plotted, on the same sheet of paper as the former. I have thought it unnecessary to reproduce these curves; the general result was to show that within the limits of errors of observation the two curves were identical, and that therefore the watts absorbed by the lamp, for the same $\sqrt{\text{mean}^2}$ pressure across the terminals, were the same, whether the gap was sparking or short-circuited. In other words, there is no sensible "skin effect" when the lamp is run on a sparking circuit.

22. As a check on the calorimeter experiment described in the last section, I tried the following. In parallel with the incandescent lamp previously (Sec. 3) used in series with the spark-gap and condenser, were connected two voltmeters, a Cardew (v, fig. 5) reading up to 130 volts, and a Kelvin multicellular electrostatic, v^1, reading up to 240.

It was anticipated that if a "skin effect" existed, it would show itself on the wire of the Cardew voltmeter as well as on the lamp, with the result that less current would pass through the voltmeter wire, less heat would be developed, and consequently the Cardew would indicate, on a sparking circuit, a lower pressure than the electrostatic instrument in parallel with it. The two voltmeters were first carefully compared with a steady alternating voltage of about 90 at the terminals of each, and the Cardew was found to read 2 volts higher than the other. The connections being then made as above, and the electrodes of the spark-gap separated, the result showed that for a mean pressure of 87·7 volts as indicated by the electrostatic instrument, the actual reading of the Cardew was 90·6 volts, and the corrected reading 88·6, or nearly 1 volt higher than the reading of the Kelvin voltmeter. The unsteadiness of the voltmeter needles made it impossible to obtain quite accurate readings; but, so far as it went, the experiment showed no tendency on the part of the Cardew to read lower on the sparking circuit. Indeed, what difference there was, was all the other way; and hence we may consider that any "skin effect," if it exists, is too small to be detected by these methods. The inference to be drawn appears to be that the oscillations produced in the current are either comparatively slow, or else are very quickly damped out of existence, so that their effect, when averaged over a half alternation, is but small.

23. However, if these two last experiments furnish merely negative evidence, there are others which tend to confirm the theory of the action in the circuit of electromotive forces of high frequency, and also to indicate that there does actually occur a considerable rise of pressure at the terminals of the lamp, although, as I have shown, it cannot be detected by the voltmeter, which gives only the mean value during the cycle. For instance, a micrometer spark-gap, Q, was put in parallel with the lamp in the fundamental experiment of Sec. 3 in addition to the gap, P, in the main circuit (see fig. 6). When the main spark-gap was short-circuited, nothing was observed at the secondary gap; but, when sparks were allowed to pass in the main circuit at P, and the lamp lit up to about 100 volts, a stream of sparks also occurred at the secondary gap, if the air space was sufficiently minute. The length of the secondary sparks was from ·015 to ·02 of an inch, indicating a maximum pressure evidently much higher than the 100 volts, or so, which the lamp, by its degree of incandescence, showed to be the average pressure at its terminals.

24. Again, it was thought possible that a vacuum tube might be used as a means of indicating the presence of high frequency currents; I accordingly varied the last experiment by substituting for the secondary spark-gap a Lowrie-Hall "fault detector." This consisted of a sealed glass bulb of oval shape, about 3½ inches long and 1½ inch in diameter in the middle, partially exhausted of air. There were no internal

Fig. 5.

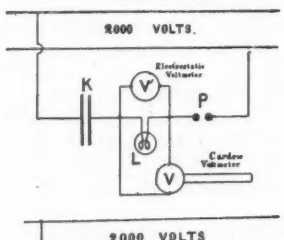
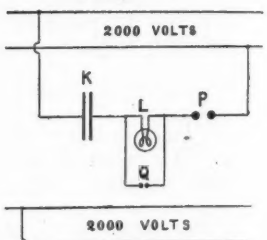


Fig. 6.



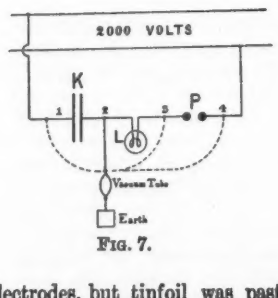


Fig. 7.

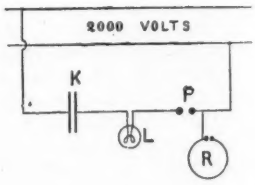


Fig. 8.

electrodes, but tinfoil was pasted upon the outside of the glass, excepting for a central zone about half an inch in width, which was left clear. When the vacuum tube was connected across the lamp terminals, on sparks passing the tube lit up faintly, the lamp glowing at about 85 volts. Now, the voltage across the terminals of the vacuum tube which could produce in it a visible glow of the same intensity, I found to be about 500 volts. The conclusion arrived at in Sec. 23 is thus confirmed, as to the existence of a maximum pressure at the lamp terminals much greater than the average pressure indicated by the brilliancy with which the lamp glows. When the vacuum tube was placed as a shunt to the spark-gap, with the electrodes of the latter in contact, there was, of course, no glow; when sparks passed the tube glowed brightly, as was to be expected, since the pressure across the spark-gap, just before the passage of a spark, must be considerable.

25. The tube was then connected to different parts of the circuit successively, its other pole being earthed. Under these conditions the glow was only faint, and apparently of about the same intensity in each case. On sparks being allowed to pass, however, the tube lit up very much more brightly. The glow under these conditions appeared to be rather brighter when the tube was connected between points 2 and 3 (fig. 7) and earth, than when connected between points 1 and 4 and earth. This observation was confirmed by the substitution of a high tension electrostatic voltmeter for the vacuum tube. With the gap short-circuited, the pressure indicated was 1,000 volts between any part of the

circuit and earth; when sparks passed, the volts shown were as follows:—

From point	1	to earth	... ...	1,000 volts.
"	2	"	... ...	1,500 "
"	3	"	... ...	1,500 "
"	4	"	... ...	1,040 "

There thus appears to be no doubt that the charge and discharge of the condenser is accompanied by a rise of pressure in the circuit, and it is difficult to see how this is to be explained, except by assuming the existence of rapid oscillations. It seems hardly likely that the arc produced at the spark-gap can so modify the electrical capacity of the circuit as to give rise to a so-called "Ferranti" effect, and I know of no cause except the two I have named which could lead to an increase of pressure.

26. Hertzian effects, also, were produced in the neighbourhood of the spark-gap when sparks were passing, tending to confirm the view that oscillations were taking place in the circuit. For instance, a Hertz circular resonator of about 12 inches diameter (R, fig. 8), with a micrometer spark gap capable of very fine adjustment, had one of its knobs connected by a thin copper wire with one of the electrodes of the main spark-gap, P, in the experiment of Sec. 3. When P was screwed up, or the electrodes otherwise short-

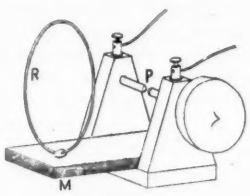


Fig. 9.

circuited, no sparks were seen on the resonator; but immediately the short-circuit on P was removed, or the electrodes separated so that sparks passed and the lamp, L, lit up, a stream of minute sparks passed between the knobs of the resonator. This is simply a repetition of one of Hertz's fundamental experiments, and would seem to prove that at every spark which passes at P, there is set up in the circuit a series of oscillations of electromotive force of high frequency.

27. Again, a closed ring, R (fig. 9), $2\frac{1}{2}$ inches in diameter, made of No. 22 copper wire, was fixed vertically on edge by means of sealing-wax to the uppermost plate of a pile of mica, M, about $\frac{1}{4}$ inch thick, so that the plane of the ring was parallel with the axis of the electrodes, and at a distance of 3 inches from the spark-gap P. The base and uprights of the micrometer spark-gap were made of ebonite, so that the insulation of the ring from the main circuit might be considered perfect.

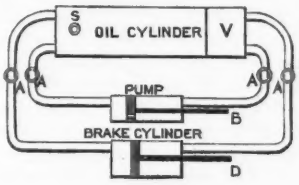
When sparks passed at the gap, P, minute sparks could also be drawn from the copper ring by any metallic body, or by the finger; and this is clearly a Hertzian effect, only to be explained by electrical oscillations of high frequency in the main circuit.

(*To be continued.*)

A NEW HYDRAULIC BRAKE FOR STREET CARS.

On May 26th an exhibition of a new hydraulic brake was given in Brooklyn on one of the cars of the Brooklyn City Railroad Company. Car No. 3,701, of the Myrtle and Gates Avenue division, was fitted up with the new brake manufactured by the Lombard Hydraulic Brake Company, 51, Hampshire Street, Boston, and through the courtesy of Mr. G. W. Goodwin, division superintendent, a number of street railway engineers made the trip from Fulton Ferry to Richmond Hill and back to test the operation of the brake.

A general idea of the mechanism is shown by the accompanying diagrammatic illustration, taken from the New York *Electrical Engineer*. The large cylinder shown on top is divided into two separate compartments, one of which contains oil at a pressure of about 220 lbs., which may vary somewhat with the grades to be travelled, and the frequency with which the brake is to be used. There are two pipe connections at each end of these cylinders, as shown, one set connecting the oil chamber and vacuum chamber, V, through the pump, whose piston rod, B, is geared to the car axle, and the other pair of pipes connecting the same cylinders through the brake cylinder, whose piston rod acts directly on the brake beam. A safety valve, S, is placed upon the oil cylinder in case the pressure of oil should become too great. It consists of a flat cylindrical box, whose outer face is made of a thin disc of metal, perforated by a pinhole at the centre. Behind this hole a screw presses just hard enough to prevent the oil escaping when at its maximum pressure; but if the pressure should rise above the point for which the gauge is set, the front disc is pressed out, and allows some of the oil to escape, thus reducing the pressure. The operation is as follows: A valve is opened to the outside air, which is pumped into the



oil cylinder until the required pressure is obtained, when the valve is closed. The valves, A, A, A, A, in practice are combined into one four-way valve, and when this is opened, the pressure from the oil cylinder is transmitted to the brake cylinder piston, which moves forward and actuates the brake beam according to the amount of oil admitted behind it. The important feature of this admission valve is that it allows the oil to pass when the hand lever is moved, and shuts it off when the lever stops, in no matter what position in its range. Thus a movement of an inch on the hand lever puts a slight pressure on the wheels, which remains constant while the lever keeps its position, and is increased if the lever is turned forward; but if is turned off, the oil escapes from the brake cylinder into the vacuum by an outside port, not shown, and from the vacuum it falls by gravity into the pump, by which it is returned to the oil cylinders under its original pressure. It will therefore be seen that, while the pump is running constantly, its piston is moving in a vacuum, and it absorbs no power except at the moment that the brake is turned off, when it pumps the oil used in braking back into the oil tank.

As the brake is used and released, it will be seen that the oil travels in a closed circuit from the oil cylinder to the brake cylinder, then to the vacuum chamber, from there to the pump, and lastly, back to the oil cylinder, into which it is forced at its original pressure. The entire operation is controlled by the movement of one hand lever, and the brake is designed to be used constantly, not as an emergency brake. It is attached at the same point of the brake beam that the ordinary hand brake is fastened, and the use of one is entirely independent, and does not interfere with the use of the other.

On the return trip several trials were made to test the efficiency of the brake in making quick stops. With a 32-foot car running at about 22 miles per hour, the stop was made in two car lengths from the place the brake was applied. At 17 miles per hour the same car was stopped in 36 feet, while at the ordinary rate of 8 or 9 miles per hour, the car was easily stopped within 6 or 8 feet.

SINGLE-PHASE ALTERNATING CURRENT MOTORS.

By W. G. RHODES, M.Sc.

The ever increasing demand for power distributed electrically is bringing forward hosts of inventors who are daily offering readier means of supplying motive power and power for lighting purposes from the same mains without the one interfering with the other. The besetting difficulty is

usually excessive current that motors take on starting under load, thereby causing an unsteadiness in whatever lamps may be on the same circuit. The expense of employing separate circuits for lighting and motive purposes is usually prohibitive, since such an arrangement would require two sets of generators at the central station.

The simplicity of generating and transmitting power by means of alternating currents has led to its frequent adoption, and we venture to think that in the not far distant future the direct current method will be of interest merely as a matter of history. The tendency is to render as simple as possible everything connected with the generation, transmission, and distribution of power. The use of polyphase currents has been adopted on account of the difficulty encountered with single-phase alternating current motors. Single-phase motors could not be made to start without more or less elaborate arrangements for running them up to speed. The obvious necessity of providing self-starting alternating current motors prompted the invention of rotary magnetic field motors. These have been brought to a high degree of perfection, and now electrical engineers are endeavouring still further to simplify the electrical distribution of power by producing self-starting single-phase alternating current motors, either of the synchronous or non-synchronous type, devoid of any complex starting gear such as has hitherto prevented them from becoming a commercial success. It is probable that we shall soon be supplied with single-phase alternating current motors which will be capable of starting under load with the same ease as an ordinary continuous current motor.

In the *Electrical Review* of New York for May 27th and June 3rd is given a description of a new single-phase, self-starting, synchronous motor. The armature of the motor has two distinct windings, one connected to a commutator as in a direct current motor, and which is used for starting and afterwards for exciting the field. The other winding is wound so as to create alternating poles in the armature, so that when the motor is got up to speed it will continue to run in synchronism with the alternating supply current.

An ordinary double-throw switch placed on the top of the motor is used for starting. In one position of the switch the lead wires which conduct the alternating current are connected through the switch-blades to one of the commutator brushes. The current is thence led through the armature winding to the opposite brushes, and then through the windings on the field poles. The motor thus starts as a direct current series motor, and is run as such until synchronism is attained. The double-throw switch is then reversed, so that the leads are cut off from the commutator and connected to the collector rings, to which the other armature winding is attached; the commutator brushes are simultaneously connected to the shunt field windings, the commutator being then used simply to supply the small direct current necessary to magnetise the field.

The time required to run these motors from standstill up to synchronism varies with the size, &c., of the motor, from 5 to 15 seconds, or from 15 to 30 seconds, according as they are started light or under load. The starting current varies from 25 to 50 per cent. of the current when running synchronously. The field excitation is controlled by means of a variable resistance placed in a recess at the base of the motor. The mechanical details of these motors have been carefully attended to, care being taken to make the structure as substantial as possible. The bearings are of bronze, and are self-oiling, the lubrication being performed by means of rings dipping into the oil chambers. The rotation of the shaft carries the rings round, and lifts up sufficient oil to provide ample lubrication.

For purposes for which constancy of speed is an important item, these motors are particularly adapted. Being essentially of the synchronons type, they must either run at a perfectly constant speed, or fall out of step and come to a standstill, and it is asserted that they will stand 50 per cent. of an overload with perfect ease and safety.

From the supply companies' point of view, these motors ought to be considered good, since they can be worked with little or no idle current. From the consumers' point of view, they may not be so satisfactory. A commutator is an adjunct of a motor which ought to be discouraged. There will be sparking at the brushes at starting, which will render the motor absolutely useless for mining purposes. The actual process of starting these motors is simplicity itself, all that is necessary being to reverse a switch; but the presence of the commutator may be a source of endless trouble and annoyance.

REVIEWS.

Miscellaneous Papers by Heinrich Hertz: with an introduction by Philipp Lenard. Translated by D. E. Jones, B.Sc., and G. A. Schott, B.A., B.Sc. London: Macmillan and Co., Ltd.

Few books are more interesting and instructive than collections of the papers of distinguished investigators; and if a work is to be judged by its fruit, it would be difficult to name a series of more valuable contributions to physical science than those made by the lamented Hertz. His papers on "Electric Waves" have already been published in English, and the present volume of miscellaneous papers forms the first volume of his collected works, which will be completed by a third volume, now in the press, containing his "Principles of Mechanics."

The introduction to this volume, by his famous pupil, Prof. Lenard, throws an interesting light on the personal history and character of Hertz. His original intention was to become an engineer, but he had not proceeded far with his engineering studies when he found that his true avocation was physical research. We can imagine that it required considerable resolution on the part of a young man to give up the prospect of a lucrative career for the love of pure science with a pittance. This, however, is what Hertz did, and we get, perhaps, the key to his character in the motto which he quoted from Schiller in his letter to his parents announcing his decision. "*Und setzt Ihr nicht das Leben ein, nie wird Euch das Leben gewonnen sein.*" For many young men it would be dangerous to act on this principle, for unless enthusiasm is backed up by ability, the result would be disastrous. Hertz, however, staked his life on it and won.

Hertz, therefore, left Munich where he had been studying engineering, and went in 1878 to Berlin to become a pupil of Helmholtz and Kirchhoff. In the physical laboratory at Berlin he carried out many important researches, which are to be found described in this volume.

The papers cover a wide range of subjects, both mathematical and physical. Two relate to elaborate experiments made to determine whether the electric current possessed inertia, and which led to a negative conclusion. Others relate to such abstruse mathematical subjects as induction on rotating spheres; the distribution of electricity over the surface of moving conductors; the contact of elastic solids; and on the distribution of stress in an elastic right circular cylinder.

A paper on an absolute method of determining hardness is probably destined, like so many more of Hertz's papers, to be epoch making. Instead of the rough empirical test by scratching hitherto used by mineralogists, Hertz gives the following rational definition of hardness:—The hardness of a body is to be measured by the normal pressure per unit area which must act at the centre of a circular surface of pressure in order that in some point of the body the stress must just reach the limit consistent with perfect elasticity. This method has since been developed by Auerbach, and shown to be capable of giving determinations of surprising accuracy at least in the case of transparent minerals.

The meteorologists, as well as the mineralogists, have also benefited by the fertile genius of Hertz. The hygrometer which he describes in a couple of pages, is a model of simplicity and accuracy, and ought, we think, if generally known, to displace the present somewhat rough and cumbrous devices. In Hertz's instrument a piece of blotting paper is saturated with chloride of calcium and suspended on the end of an arm attached to fine stretched silver wire. The variations in the amount of moisture absorbed by the chloride of calcium causes the arm to rise and fall and thus indicate on a scale the amount of moisture in the air.

Hertz's papers on the electric discharge will be of especial interest at this time when so much activity has been excited in this field by Röntgen's discovery. One paper "On a Phenomenon which accompanies the Electric Discharge,"

written in 1883, contains the germ of those remarkable experiments by Righi on the globular discharge, which were recently described in the Electrical Review.

The papers on the cathode discharge are really the starting point of the sensational discoveries of Lenard and Röntgen; and most people who read these papers will be surprised when they learn how much Hertz has done in this field. One paper entitled "Do the Cathode Rays indicate the Path of the Current" is exceedingly interesting, and, one would think, can be by no means generally known to physicists in this country, as the experiments described therein appear to completely upset our favourite theories of the cathode discharge. Hertz mapped out the course of the current in an exhausted chamber by means of its electro-magnetic action upon a magnetic needle suspended outside. He found that the current flowed between the two electrodes in continuous curved lines, just as if they had been connected by a slab of conducting material. The cathode rays on the other hand streamed off at right angles from the cathode surface and appeared to be quite independent of the course of the current, in fact they were at some places at right angles to the course of the current. This appears to be fatal to the view that the current is carried through a Crookes tube as atomic charges in the cathode stream. Hertz struck another blow at this theory by demonstrating experimentally that the cathode stream had no measurable electrostatic influence. Another curious result observed by Hertz was that though the cathode rays are deflected by a magnet, the rays do not react upon the magnet so as to produce a deflection.

A lecture delivered by Hertz in 1889 before the German Association for the Advancement of Natural Science "On the Relation between Light and Electricity" shows that Hertz was also a master of the art of popular exposition, a by no means common gift among the most distinguished German scientists. The volume winds up with a warm tribute to his master, Hermann von Helmholtz, but this contains little that is not already well known to most of our readers.

The book has been well done into English by the translators. It contains very little trace of the heaviness that is generally felt about translations from the German, a circumstance for which we have no doubt to thank the skill of the translators as much as the style of the author.

Les Applications Mécaniques de L'Energie Electrique. Par J. Laffargue, Ingénieur Electricien, Licencié ès Sciences Physiques Ancien Directeur de l'Usine Municipale d'Electricité des Halles Centrales de la Ville de Paris. Paris: J. Fritsch.

This book is the second volume written by M. Laffargue on this important subject, but it may be mentioned that it forms a work complete in itself, and is not simply a continuation of the preceding volume. The author now deals with the practical application of electric motors in workshops and manufactories, in mines, on board ship, and in agricultural work; in fact, with all the most important applications exclusive, however, of electric traction. The author has selected a large number of installations which he illustrates and describes in detail, most of them, of course, being French; but a few examples of work carried out by English, American, German, and Belgian firms are also dealt with. The work is decidedly interesting and it is also of considerable value in enabling one to review the widely differing applications of electric motors up to date; but we must express our regret that the author has not approached his task in a more critical spirit, and clearly pointed out to the reader the glaring defects in some of the installations described.

We instinctively divide the installations into two classes: (*a*) those in which electric motors have been installed by competent engineers with the object of improving the method of working as regards economy, efficiency, and convenience, and (*b*) those in which electric power has been employed by scientific enthusiasts, simply because it is electric power and regardless of economy or efficiency. The latter class is marked out chiefly by a profusion of belts and countershafting.

In one choice example, illustrated on page 40, a motor (one of a number installed in the same factory), is employed to drive an emery wheel and a grindstone, and no less than five belts having a total length of about 70 feet are introduced. The first belt drives a countershaft at a considerably *reduced* speed; and from this countershaft an increase of speed is obtained in two steps for the emery wheel, and a further reduction in two steps for the grindstone. The loss of power must, in such a case, be enormous; the motor is placed at a considerable distance from the work and is not under the control of the workman, the space occupied by the belting and shafting is excessive, and an installation, of which the above example forms a part, must not only be bad for the people for whom it was installed, but it must also act as a solemn warning to others against the use of electric motors.

We turned with some interest to the chapter dealing with the application of electricity to agricultural work, but after a careful perusal we have to confess that the chapter contains but little calculated to assist in raising the British farmer from his present state of despondency. In one instance it is shown that it is cheaper to plough by electricity than by oxen, the former method costing about 25 francs and the latter 62 francs per hectare. We are astonished at the result as the electrical equipment includes a portable steam engine and boiler, a dynamo (on a separate carriage) driven by a belt, and a long length of cable trailing after the plough upon which is fixed the motor. It is evident that this plough as constructed would be perfectly useless for work in heavy soil, and in any case we cannot conceive any reason for not using the engine directly to haul the plough in the usual manner if it is considered necessary to bring an engine into the field at all. In our opinion there can be little chance of successfully employing electricity in agricultural work, unless the power can be cheaply obtained from a waterfall in the vicinity. M. Laffargue describes one such installation which is worthy of the closest attention.

The book contains many other good examples of the judicious application of electric motors, the machines being compact, working direct or by the aid of a simple gearing, and easily under the control of the workman. We can only regret that the author has not distinguished more clearly between the good and the bad engineering jobs, but for the reader who can himself so distinguish we recommend the book as an interesting record of work which is now actually being performed by stationary electric motors.

Matriculation Directory. The University Tutorial Series.

As long as the London University remains a mere examining body, such associations as the University Correspondence College are an exceedingly useful, if not absolutely necessary aid, to the candidate for University degrees. The staff of this college are evidently men of the highest qualifications, and generally men who have themselves obtained the London degrees with distinction. The prospective graduate will therefore do much better by putting himself under the direction of such an institution as this, with its large staff of specialists, than by trusting, as he frequently does, to some of the incompetent Poobah's who shine in newspaper advertisements. This publication contains sketches of courses of study, specimens of examination papers and lists of books recommended to students, and will be, therefore, of great value to those who do not wish to go to the expense of being fully prepared on all subjects.

Opening Bridges. By George Wilson, M.Sc. The Technical Publishing Company, Manchester, 1896. 2s. net.

If we are to accept the decision of a Mr. Jas. Price it would appear that the Roman camp at Manchester was surrounded by a ditch which was crossed by means of a drawbridge. Mediæval castles had Bascule bridges over their moats like the present Tower Bridge. Though so ancient, there is not much literature upon drawbridges, and what there is is chiefly American.

The present author seeks to amend this by a general descriptive and critical account of swing bridges, in which he considers such matters as pivots, rollers, the ratio of length of the two arms when different, and the economy to be thereby gained, as to which, however, it may be said that American practice favours equal arms and is supposed to be specially

based on economy, the American tendency being in the direction of symmetry, whereby a manufacturing rather than an ideal economy may be secured, not to mention the better balance of wind stresses and ease in opening thereby secured in a gale. There are tables of some of the principal swing bridges in the world, and a good deal of general information; but this is hardly a finished treatise on swing bridges.

GOOD REGULATION AND THE SHAFT GOVERNOR.

The subject of shaft governors is dealt with by Mr. E. T. Adams in the *Electrical World* with a view to showing how a governor is to be arranged to secure a desired minimum of speed variation.

He would call good regulation 2 to 3 per cent. between full load and frictional load.

To accomplish this a governor should have little friction and great power, and it often pays to add to the weights for the purpose of getting a more powerful governor, for it is to be remembered that the power of a governor is simply the difference of the centrifugal force of the weights and the limits of speed and the pull of the springs. Hence doubling the weights and adding stronger springs, doubles the acting force of the governor.

A governor may be adjusted (*a*) by changing the amount of the weight or its position upon its arm; (*b*) by changing the spring, or its initial tension or its point of attachment upon the weight or upon the rim; (*c*) by changing the length of the links between the weight arm and the sheave arm.

Beyond this much cannot be done. Obviously, if the weight be increased, it will be necessary to alter the spring either by renewal or by varying its tension or points of attachment, in order to properly balance the weight. Friction is undesirable, and it is plain that the nearer the point of attachment of the spring is to the fulcrum pin of the weight arm, the greater will be the friction and the less easy the action of the governor. That spring is best, therefore, which can be attached nearest to the weight.

Much depends on springs. They will vary by 100 per cent., even when of same dimensions, so that it is best to secure springs from a really good maker, and to supply him with data, such as the space available for the spring and its desired tension at two limiting positions. It is useless attempting to calculate a spring off hand by the usual formula, though really good springs will correspond with the formula. In ordering a spring, therefore, a drawing of the governor should be made, showing the extreme positions of the C.G. of the weight and arm, the shaft centre and fulcrum pin and spring attachments. Then, if the ratio of the lever arm of the spring attachment and of the lever arm of the C.G. of weight and arm is the same at all positions of the weight, the spring tension may be easily calculated by finding the spring tension necessary to resist the centrifugal force of the weight at each of its extreme positions. The difference of the two forces divided by the difference of length of spring, *i.e.*, by the movement of the spring attachment, is the tension required per inch of stretch, and the minimum pull of the spring, divided by the tension per inch of stretch, is obviously the initial extension length. Thus the required spring must be such as will stretch initially so many inches at so many pounds per inch, and it must be capable of being put in the space available. The formula for centrifugal force is $0{\cdot}00034 \times W, R, N^2$, where W is the load, N, the revolutions per minute, and R the radius of revolution in feet, so that for a weight of 30 lbs. and two limiting radii of revolution of 10 inches (·83 feet), and 16 inches (1·33 feet), the centrifugal pulls are 765 and 1,260 lbs., when the speed of revolution is 300 and 305 revolutions respectively for limiting positions. These figures multiplied by the ratio of weight arm to spring leverage, yield the figures for spring tension. The ratio of lever arm is given as $10\frac{1}{2}$ and $7\frac{1}{2}$ (inches), so giving a spring pull of 1,070 and 1,765, or 695 lbs., spread over a stretch of 4 inches, which is the spring movement, giving 174 lbs. per inch, and a total stretch of 1,765 − 174 = say, 10 inches maximum stretch and 6 inches minimum stretch, when the weight is in at smallest radius. The spring thus obtained, any slight necessary adjustment can be readily made by shifting the attachments. The changes are considered, which are made by varying the length of the link, and by shifting the spring attachment in the rim, whereby variations can be made in the ratio of the moments of weight and spring; but these can be investigated by means of diagrams, and their effect determined. In starting an engine after a change has been made, it is desirable to do so carefully, and not give a less than full tension to the spring until its behaviour is seen. Then a further tension can be given, until full regulation is secured. A dash-pot should not be put in connection until all experimentation is complete. A dash-pot is, after all, merely a means of controlling and steadying the governor action, but it should not be made to cloak any actual vice.

Too much care cannot be taken in taking down a governor, in the marking of parts to go up again as before. Carelessness in this might lead to serious racing—indeed has, in one instance at least, wrecked the engine and lost the engineer's life.

CORRESPONDENCE.

On Celluloid and Accumulators.

I have read a short communication from your correspondent, "A Spectator," on the above subject.

Several times lately I have seen celluloid abused, but have not seen a minute description of what actually takes place, nor in what manner the battery is affected by it.

Mr. Crompton, in giving evidence a few months ago, stated that celluloid was absolutely worthless for accumulators, or words to that effect, and this was the first time I had seen it condemned.

Previously to this, I had a great deal of trouble with a large battery with celluloid forks and bearers. These, I noticed, became covered with a slimy black coating, which, on being washed off, left the forks perceptibly thinner.

If "A Spectator" or any other correspondent who has studied this subject would publish their experience, it might help some engineers who reckon large batteries as one of their anxieties.

A Cell.

The Power of a Horse.

From your remarks under the head of "Notes," I learn that someone has been criticising my letter on this subject. I have not seen it, as I have always found in the Review sufficient to keep me abreast of the progress in electricity, and not being an electrician myself, I have always felt its conspicuous fairness when dealing with matters in which electricity is a competitor for public favour.

Well, I am not surprised that the statement I made as to the great power which a fine, powerful horse can exert for a short time should be received with some hesitation.

Regard for your valuable space led me to withhold some particulars which I should have given.

What I wanted to establish for the benefit of those who are devoting their thoughts to the use of electricity or other powers for traction, was the greatest power which could, by horses, be applied to vehicles, such as trams, and from this make their deductions to suit their own case.

The horse in question was the pick of a stud of about 40, and when what I call the "special test" was made, he was drawing two waggons against a gradient of 1 in 164, with some of the wheels spragged, to compel him to exert his full power, and he then, as I said, travelled 138 feet under the strain I gave. Of course, when a horse takes his first lift at a heavy load, he throws his dead weight into the collar, and it is impossible to separate what is mere weight from muscular exertion; but here he has the advantage over machine power. I send the only diagram I find amongst my papers, to show you the enormous strain which a horse, by weight and power combined, exerts at the start.

Now I will give you a little more detail from Morin's "Mechanics," in support of my statement. He says (page 396), speaking of canal boats:—"In exceptional cases, where the wave is in front, we have said that at the velocity of 13·84 ft. the resistance has sometimes equalled 617 lbs.,

which exacts from each horse an effort of 205·66 lbs., and the excessive work of 205·66 × 13·84 feet = 2,846 foot pounds in one second, during a time of more than one or two minutes, whence results, &c."

For those who are seeking information on the draught of vehicles on ordinary roads, in various states of mud and roughness, I cannot recommend them to a better book than his work, "Experiences sur le Tirage des Voitures," 1842, where they will find every phase of the question exhaustively treated.

A. L. Stevenson, M. Inst. C.E.,
Past President of the North of England Inst. of Mining Engineers.

Durham, *July 25th*, 1896.

[The diagram, which was sent for our personal inspection only, gives a very graphic representation of the starting power which all machines, of course, have to provide for.—Eds. Elec. Rev.]

"Submarine Cable Laying and Repairing."

To those interested in submarine cable work, Mr. Wilkinson's book comes as a most welcome and valuable addition to the literature on that subject.

There is, however, one small inaccuracy, which, although of minor importance, is, perhaps, worth correction. I refer to the description of the "friction table" described on pp. 152 and 363, which is found to be a most useful adjunct to the paying-out gear in the vessels of the Silvertown Company. The designing of this is wrongly attributed in Mr. Wilkinson's book to the late Sir Charles Bright. In the discussion on the paper read before the Society of Telegraph Engineers by Mr. E. March Webb on December 10th, 1879, and to which paper Mr. Wilkinson makes reference, Mr. F. C. Webb is reported as follows :—

"Sir Charles Bright has mentioned the holding-back gear was designed by him. I have always understood (of course I may be misinformed) that Mr. Matthew Gray designed it at the time of laying the West India cable, but I may have made a mistake. Perhaps it was when he was there with Mr. Matthew Gray. The screw gearing referred to by Mr. March Webb was put on by me, and was not in the ship when it came back from the West Indies. I mention this because Sir C. Bright's remarks would appear to imply that the whole machine, as there shown, was made to his instructions in the West Indies, and that thus I had claimed what I had no right to claim. I feel sure Sir Charles intended only to allude to the machine without the screw gearing, although he did not make this clear."

To this I would only add that Mr. F. C. Webb was correct in attributing to Mr. Gray the origin of this apparatus.

M. H. Gray.

Silvertown, *July 29th*, 1896.

Re the Britannia Motor.

In reference to your criticism *re* the above in your current number, I beg to say that I consider most people have yet to be convinced that the electric motor industry has arrived at such a degree of perfection, that it is impossible for one such motor to excel another, or to be more suitable than another for traction or other purposes.

The Britannia motor is the only motor in which both armature and field magnets revolve on the axle of the propelled vehicle.

Its suitability for certain purposes, such as driving shafting or motor cars, is evident, therefore, as the motor itself can be supported by the shaft or axle it is driving.

Chas. O. Bastian.

July 29th, 1896.

[The Britannia motor is not the only motor in which armature and field magnets have both been made to revolve; but where are the forerunners of the "Britannia" now? We fail to see that Mr. Bastian makes out a better case for the company than did the worthy chairman whose speech we commented on.—Eds. Elec. Rev.]

AUSTRALIAN NEWS.

There seems to be now a reasonable prospect that the Sydney Municipal Council will shortly be in a position to undertake the lighting of the city by electricity. Clauses 5 and 6 of the Bill relating to the sub-letting of the powers conferred on them by the Bill having been withdrawn, the labour party has withdrawn its opposition to the passing of the Act, and it has now reached its second reading and passed into the committee stage. The House is also engaged in the consideration of a number of Bills relating to bridges over, and a tunnel under the harbour connecting the suburbs on the north shore with Sydney, all of the schemes embracing electric traction in some form or another. The report of the Public Works Committee on the proposed electric train in George Street, Sydney, has been tabled in the Legislation Assembly. The estimated cost of the work is £123,000, and the railway commissioners estimate the total annual cost at £32,497, the annual revenue being set down at £45,900. The committee consider that George Street is sufficiently wide, even at its narrowest part, to carry a double line of tramway; that portion of the power required can be supplied from the Ocean Street cable-tramway power house, and that the overhead system is the best. The contract for the supply and erection of generator, shafting, &c., at the power house, North shore, for the Mosman's Bay electric tramway, has been secured by Messrs. H. H. Kingsbury and Co., Margaret Street, Sydney, the overhead material for the same work being supplied by the Brush Electrical Engineering Company.

In Perth (W.A.) the City Council have had several schemes under offer for providing the city with tramways, the latest being an offer from Coates & Co., of London, the chief feature of this proposal being an overhead electric system. After a good deal of discussion, a resolution was carried to the effect that the council will not entertain any scheme whatever under private ownership, but when the time arrives they will construct and work a system themselves for the benefit of the residents and citizens. The construction of the first section of the new inter-colonial telegraph line connecting Perth with Adelaide, has been completed. This section is that connecting Coolgardie with Dundas. The material for the second section is now in the colony and will be shipped to its destination during next month, and the progress of the work is now assured, as there is a good water supply along the route of the second section connecting Dundas with Eucla.

An ingenious invention has recently been brought out by Messrs. Folk & Ellis, of Melbourne, the object of which is to provide a complete and automatic safeguard against the racing of the screw of ocean steamers during rough weather. A solenoid is so adjusted to the throttle valve that as the plunger rises or falls, the supply of steam to the engines is increased or diminished, or finally cut off altogether. This solenoid is connected in a circuit from the ordinary dynamo of the ship, and the strength of the current passing is controlled by the movements of the stern of the ship in the following manner: along each side of the stern post is placed a narrow strip of copper insulated and connected with the circuit already mentioned supplied by the ship's dynamo. When the stern is immersed to a proper depth in the sea, the circuit is completed and the normal current passes. As soon as the stern is raised, the strength of the current is decreased until, if the screw rises near or above the surface, the current is cut off. In proportion as the current passes so does the apparatus regulate the supply of steam to the engines, and thus it is claimed is secured a perfectly automatic and instantaneous control over the movements of the screw. By the proper adjustment of the length of the strips of copper in relation to the position of the screw, the action of the governor can be made to complete itself either when the screw emerges from the water or as it approaches the surface. A company has been formed with a capital of £2,500 in £25 shares, and Mr. Folk has left for England to try and push the invention.

In an action brought by the Weir Australian Electric Company (Melbourne) to recover £17 odd from a customer for light supplied, heard in the Melbourne District Court on May 22nd, an objection was raised that the plaintiff company could not succeed in any action until an Order in Council had been made authorising such companies to construct lines and supply electricity as required by Section 5 of the Electric Companies Light and Power Act. So far no such order has been made, and the company is, therefore, out of court. On behalf of the plaintiffs it was urged that if such an objection was sustained, all the electric lighting companies would be ruined—they would be at the mercy of their customers. The P. M. said he would have to uphold the objection, and strike out the case, without making any order as to costs.

Another water and electric power scheme is before the Victorian Public. To supply the town of Creswick with water, and to provide power for driving the machinery in connection with gold mining, it has been proposed to construct an embankment, 60 feet high at the highest point, which would store 1,400,000,000 gallons of water. It is estimated that this could be effected for about £10,000, and that an additional sum of the same amount would bring the supply to an elevated point about half a mile east of the township, for producing electric power for lighting and the driving of machinery. The storage could be increased if necessary to give a continuous supply of 1,000 horse-power. It is stated by the promoters that the cost of driving machinery by electricity derived in this way would be less than one-third that of steam power, and this would make it profitable to work reefs which have been abandoned, as the cost of crushing by steam power was found to be too large.

I regret to have to announce the death from influenza of Mr. G. F. Clements, M.I.E.E., A.M.I.C.E. assistant electrical engineer to the Railway Department. Mr. Clements, who died at the early age of 28, had shown great aptitude and enthusiasm for electrical work, and had been of much assistance to Mr. P. B. Elwell, in carrying out

the developments which the Railway Commissioners have had in hand in the introduction of electricity to railway and tramway work. He was one of the cadets selected by the Commissioners to proceed to England to obtain a wider experience than was available in the colony. Mr. Clements left Sydney in February, 1890, and returned in April 1892, having spent the greater part of the time in the works of Messrs. Siemens Bros. He recently read a very able paper before the Electric Club of New South Wales, on the "Electric Tramway at North Sydney."

Prof. Forbes has just passed through Sydney on his way to New Zealand, and the Electric Club of New South Wales were so fortunate as to prevail on him to address them on the subject of the Niagara Falls power scheme, and a crowded house listened with much interest, a number of lantern slides prepared from *Cassier's Magazine* by two members of the club adding very materially to the interest of the address. Prof. Forbes was also entertained at a luncheon given by the Electric Club as a welcome on his arrival.

At the annual meeting of the Medical Section of the Royal Society of New South Wales, held at the Sydney University, a lecture was delivered by Prof. Threlfall on "Röntgen Rays." After the lecture several "radioscripts" (as Prof. Threlfall has it), were taken. One was of the arm of a boy who had been accidentally shot in the wrist, the result showing the bullet embedded in the large bone of the arm, about 2 inches distant from the point at which the arm had been probed in search of the bullet. The case was interesting, because it was one in which all the attempts to find the bullet had failed, and it was desired to ascertain its position in order to perform an operation for its extraction.

Another patient was also experimented upon. He had contracted a disease of the bones in the arm about 11 years ago, and it was desired to ascertain the extent to which the disease had extended. The "radioscript" showed that the disease had gone further than was thought, the large bone or radius having become affected. Dr. Hankins, who has charge of the patient, intends to use the information thus obtained and to perform an operation on the arm and scrape the affected bone.

Lastly, Prof. Threlfall enabled some of those present to examine the bones of their own hands by placing the tube in a cardboard box and enveloping the head of the experimenter in a fluorescent screen, inserting his hand between the screen and the box.

Similar experiments have been carried out in Melbourne.

Sydney, *June* 22*nd*, 1896.

VIBRATION IN HIGH SPEED ENGINES.

We referred some time ago to a paper by Mr. Allan on the above subject which was read before the North East Coast Institution of Engineers and Shipbuilders, and we objected to Mr. Allan's reasoning because he took account of steam pressure as a producing cause of vibration. We always have objected to the consideration of steam pressures in this connection, considering that the one object to aim at in the balance of all rotary or other machines is the preservation of a constant C.G. of the whole mass. Vibration proper is not due to forces of an immaterial nature, but arises simply as a result of mass displacement. The further discussion on the paper has now been published and it is satisfactory to find that both speakers in the discussion, Messrs. Doxford and Ferrier, took their stand on the simple fact we have always laid down, and so also do nearly all the critics by correspondence. Curiously enough, however, the only favourable letter is from Mr. Yarrow, who "has no hesitation in saying," from his brief examination of the paper, "that the matter has been most ably dealt with." Now Mr. Yarrow does know something about engine balancings. We have heard him named Mr. Bobweight Yarrow, which our readers will understand at once to have reference as to Mr. Yarrow's perfectly correct belief in bobweights as the true means of balancing the reciprocating weight of an engine. Obviously, therefore, his study of Mr. Allan's paper must have been very brief indeed, for it flatly contradicts Mr. Yarrow's own correct position. Two of the members, Mr. Doxford and Mr. Ferrier, have themselves read papers on the same subject before the same Institution. So far as high speed engine balancing is concerned, we are and now long have been convinced that engineers are far too deeply rutted in the groove of crank angles to permit them to arrive at practical results in balancing. Years ago, in factory work, when engines revolved at 17 or 18 turns per minute, the coupling of two such giants with cranks at 90 degrees was undoubtedly a great improvement in steadiness of turning effort, and powers of 800 H.P. would be dealt with in this manner with a fly-wheel of 30 tons and give perfect driving. But a more modern single crank engine revolving at 50 or 60 turns per minute, and having a much heavier fly-wheel has a far steadier rotative action on its load. With such examples as these always full in face engineers have gone on heaping up troubles for themselves simply because they have persisted in adhering to a fancy as regards crank angle, where the impulses per second are too frequent to require any consideration of the question of turning effort being indulged in. In the old factory engine there was no vibration. There was considerable shifting of masses but not at such speeds as to constitute vibration. Vibration can only arise where there is rapid to and fro movement of the centre of gravity, and in the high speed engine it is far more necessary and important to give attention to the question of vibration than to any such out of date folly as turning effort uniformity, the ghost of which still stalks abroad to the terror of engine builders, and leads them to perpetrate such follies as that of "Selected American Patent No. 555,698, *The Engineer*, June 12th, 1896, page 606," wherein one Heilmann can only see his way through an assemblage of six cranks to an end he could better attain with three. In an electric light station using small high speed units it is pitiable to think how much is sacrificed to the bogey of "ability to start from any position," as though it were essential to start always without the use of the bar or its equivalent. A modern high speed engine is almost on a par with the turbine in its turning effort when running at several revolutions per second and should be dealt with purely as a piece of revolving machinery and not at all in relation to its descent from the steam engine of 50 years ago. It is a mechanical absurdity to place a three-cylinder engine with cranks at 120 degrees under the impression that a balance is thereby secured. The result is simply to set up a twisting couple in a plane normal to the direction of piston movement.

It is as often these twisting couples as anything else that cause trouble from vibration, and they arise from an apparent inability of designers to see that two weights revolving in different planes cannot be made to balance one another. There must be revolution in the same plane, or else a third disturbing force in a third plane of revolution. But we repeat it is useless to trouble about the steam stresses. These are not causes of vibration in the true sense, nor can they be dealt with in the manner that actual moving pieces can be dealt with. Steam stresses call for sufficiently stiff bed-plates, and, given strength of parts, very little further can be done. There appears to be an impression that by reason of the inertia of the moving parts, the steam stress on the top cover of the cylinder is not communicated to the crank pin, and, therefore, the tendency in a ship is to lift the ship out of the water. Grant this to be so, can Mr. Allan or any other man overcome the difficulty, if it be one, by any system of balance? But, after all, we think Mr. Allen and his critics are not arguing on parallel lines. Mr. Allen clearly had in view the structural weakness of a ship and the stresses set up by the steam, but he overlooked the fact that the inertia of a piston is overcome by the tail of the crank, and that in an engine fully balanced for vertical forces the piston is pulled down or up by the balance weight at the expense, however, of a disturbance horizontally. With bob weights, however, moving in right lines like the piston, gravity effects are annulled but inertia effects are doubled, and for shipwork or where there are yielding foundations, the use of bob weights set in motion by the steam is delusive as a means of avoiding stress vibrations. The bob weight must be another piston of equal mass and opposite movement, when, the two steam stresses being also opposite in direction, balance each other. But this is outside the question of balancing high speed engines. Bob weights may therefore be used to correct vibrations due to a moving C.G., but they are not good practice mechanically, unless they are made in the form of pistons capable of being set in motion by steam pressure direct instead of through a system of levers, for in the latter case the fulcrum pressures add still further to the general complication. True, the bob weight will effect its desired purpose, but at the expense of so much useless weight and complication, and hence the desirableness of making such weights actually working parts of the machinery.

THE INTERNATIONAL CONGRESS OF ELECTRICIANS.

One of the principal features of this Congress will be a visit to the principal electric installations in Switzerland, commencing on the morning of August 10th, and concluding on the evening of August 15th.

The excursion first visits the tramway installations at Lausanne, and then proceeds to inspect the electric installations at Freiburg.

The second day the excursionists visit the electric and hydraulic installations of Val de Travers and of Chaux-de-Fonds, and after viewing the works of Neuchatel, it proceeds to Berne.

On the third day, after inspecting the municipal installations of Berne, the excursion departs for Largenthel, visiting the works of Wyran, and arriving at Argau. On the fourth day, after examining the works there, the pilgrims of electricity leave for Bremgarten, visiting the works of Zufikon, which supply the manufactures of Zurich, and arrive at Lucerne, where they view the electric installations of Thorenberg.

On the fifth day the excursion crosses the Lake of Lucerne, and ascends the Stansenhorn (1,900 metres in height) by a cable railway with electric guidance, visiting the Rathhausen works, and arriving at Zurich.

On the sixth day, after inspecting the electric installations of that town, and of Oerlikon and Baden, excursionists will return to Lausanne, where the trips will formally end.

The price of ticket, including everything mentioned in the programme, is fixed at 130 to 140 francs, according to the number of excursionists. On booking, each excursionist pays a deposit of 25 francs, which will not be returned if the traveller fails to join the party, and pay the balance which will be collected on the way.

Intending excursionists may book at Geneva, at the office of the Congress, on August 5th, 6th, and 8th, from 8 to 10 a.m. The list finally closes on Saturday, August 8th, at 7 p.m.

The participants are entitled to railway conveyance second class, and first class by boat, coach, or brake for certain portions of the journey. For most part of the time the railway companies will place special carriages at the disposal of the excursionists.

The luggage of each passenger should not exceed a portmanteau of at most 10 to 15 kilos. This portmanteau should be sent to the agency (Messrs. Ruffieux & Ruchonset, Lausanne) on the morning of departure, and will be forwarded gratis by them from stage to stage.

Each passenger has merely to leave his portmanteau in his room each morning, and will find it every evening in his room at the next stopping place.

M. Ruffieux accompanies the excursion with the necessary staff.

This excursion should afford an admirable and most useful opportunity for electricians to make themselves acquainted with the practical working of almost every kind of electrical installation.

ELECTRICAL FACTORIES AND THEIR MACHINERY.

No. I.

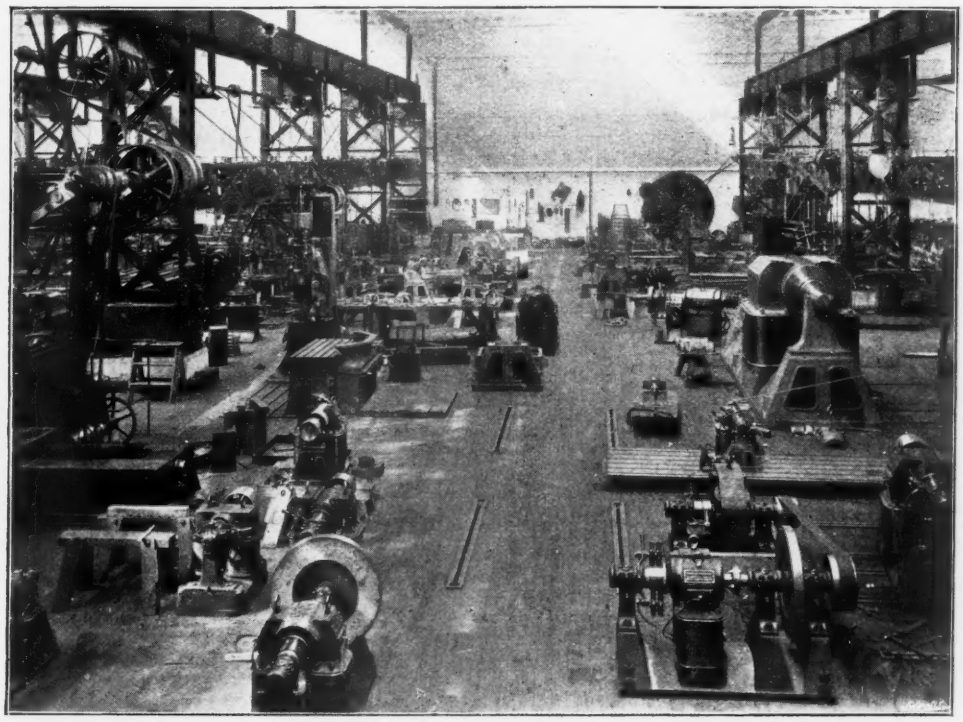
The electrical factory is, nowadays, something more than a mere workshop where machines are pieced together and magnets and armatures wound. It is essentially a place where an electrical machine, no matter what its size may be, is built up from the raw material, where shaping, milling, slotting, and kindred operations are performed under one roof, or, at any rate, in the same building. The growth of electric lighting, and other applications of electricity, have impelled a change in the methods of the manufacturer. To meet the pressing conditions of trade, he must turn out apparatus quickly, and he can only do this by having all constructive work done under his own eyes.

There is very little doubt that the various operations carried on in electrical factories call for very elaborate machinery. The increase in the size of the dynamo-electric machinery, which has been effected during the past few years, has been also a very important factor in determining the type of machine tools employed. It is proposed in these articles to give some idea of the various forms of tools that are mainly used in some of the principal electrical factories. The first workshops that we visited for the purpose of these articles were those of Messrs. T. Parker, Limited, of Wolverhampton, one of the most recently built electrical factories, and here we found a very varied collection of the latest type of tools. The works themselves, which are conveniently situated near the railway station, are extensive, and excellently laid out. Although at the time of our visit they had not been in a completed state for more than a few weeks, they bore evidence even at that time of good organisation. There was little evidence of a new business, and the construction of plant was being carried on as smoothly as in old-established works; probably the abundance of room had a good deal to do with the facility with which work was being done. The main erecting shop is a large well lighted floor, about 150 feet by 42 feet.

Here the chief construction work is carried out, the principal machine tools being located in this room. Besides the machining which is carried on here, considerable space is set apart for armature winding, field magnet winding, screw making, disc cutting, and other operations. The large erecting shop forms only a small portion of the complete works—for there is a foundry of considerable dimensions, a finishing shop, a large room devoted mainly to screw cutting and other small work, and a large building given over entirely to pattern-making and switchboard work. Retracing our steps to the main erecting shop, we note here steam engines of an aggregate horse-power of 400, divided between a Belliss engine of 250 H.P., and two Marshall engines of 100 and 25 H.P. These, besides turning a considerable amount of shafting, drive dynamos which supply electrical energy to motors in the shops. The electrical driving at Messrs. Parker's is one of the most interesting features of the works. It is interesting to mention that the motors are designed for 220 volts, the main cables which supply them being uninsulated, and carried on porcelain insulators, except where the branches are taken off to the machines, when the wires are insulated in the usual manner.

It would be impossible to set forth in detail the whole of the machine tools that are employed; the principal types are something as follows:—

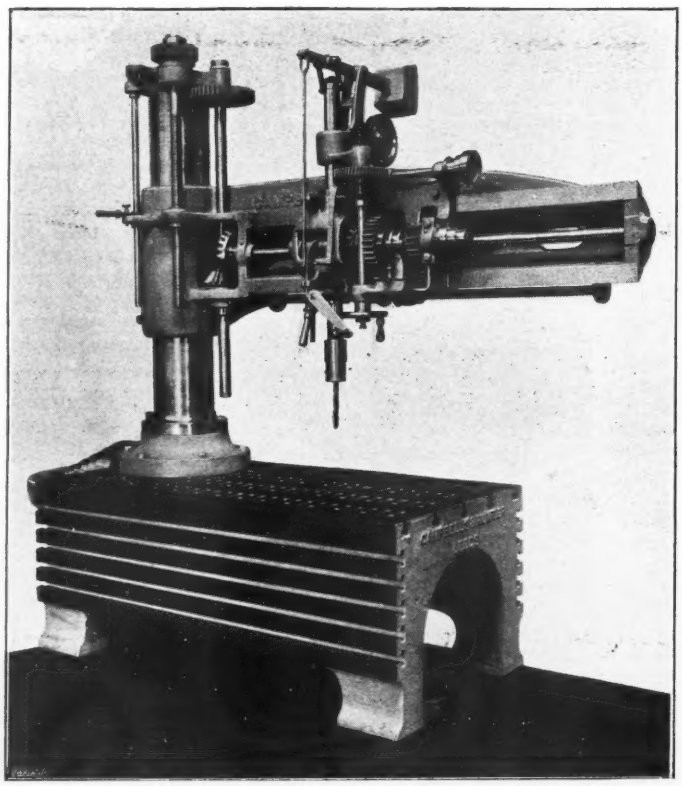
Side planing machine, 20 feet stroke, with two heads to work together, or as independent machines. Lathes of 24-inch, 16-inch, 12-inch centres, of ordinary type, by Hulse & Co. Two spindle plano-milling machines to take work 5 feet in width, and having 10 feet traverse. Treble gear brake lathe, 24-inch centres, to turn up to 14 inches in diameter, with gap 8 feet in width, by Messrs. Kendall and Gent; 21-inch, 16-inch, and 8-inch slotting machines, 18-inch double-headed shaping machine, drilling machines, lathes, milling machines, and cutter grinder of usual patterns, by Messrs. Muir & Co.; 40-inch face milling machine, lathes, and drilling machine, by the Tangyes Machine Tool Company, and radial drilling machines and boring machine, 5-inch spindle table, 16 feet × 8 feet, by Messrs. Campbells & Hunter. In addition are smaller machines, such as small lathes, milling machines, drills, supplied by Messrs. James Archdale & Co., Limited, for light work, and turret lathes by Messrs. Grenfell & Accles, Limited, Birmingham.



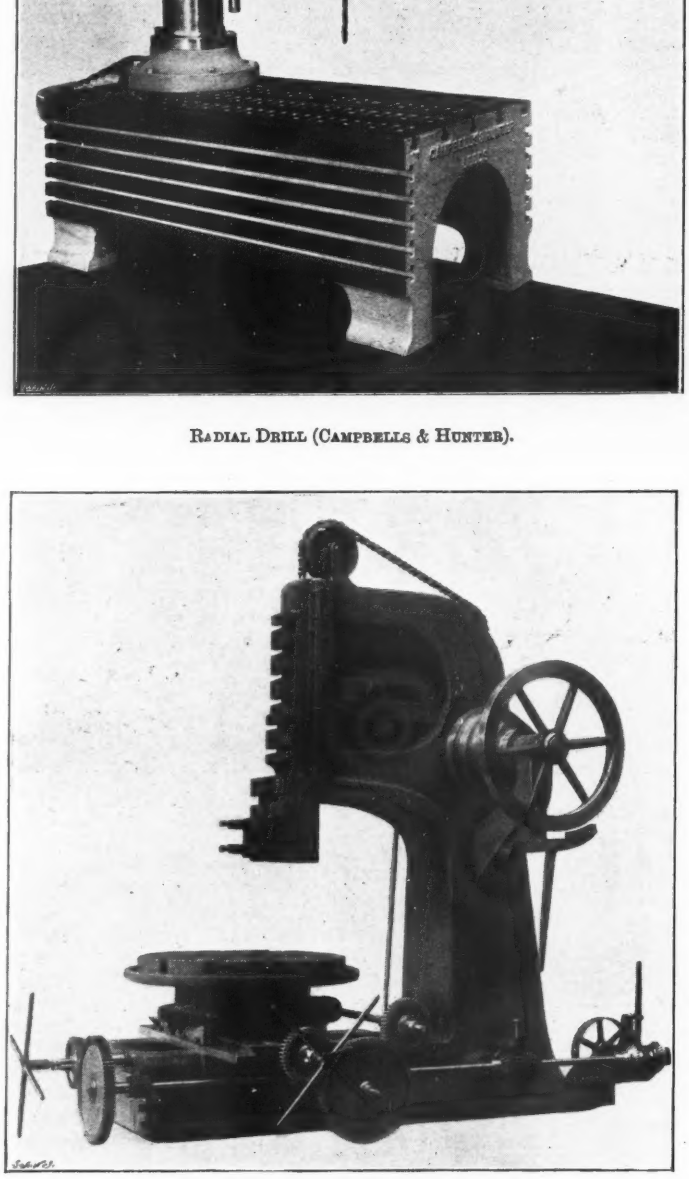
Main Erecting Shop at Messrs. Parker's, Limited.

Coming to consider the machine tools in more detail, perhaps some of the most interesting are the radial drilling machines of Messrs. Campbells & Hunter, two of which are illustrated. The larger of the two is designed to drill at a radii of 7 feet, down to 1 foot 4½ inches. There is considerable flexibility in this machine, for the arm which

carries the tool is capable of being raised to a height of 6 feet, or lowered down to 3 feet 3 inches; in addition, it is able to revolve through an arc of 180°. The machine is provided with a steel spindle, 3 inches diameter, which is operated by a self-acting or hand-feed motion of 1 foot 6 inches, by rack and pinion. The spindle is balanced by chains and pulleys, and fitted with reversing and disengaging motions for tapping, the double gear wheels forming the slow motion for tapping and boring being on the saddle. The handles for altering the speed of drill, reversing, moving the saddle itself along the arm, and for radiating the arm, being carried on the saddle. The column which carries the arm is 4 feet 6 inches × 4 feet 6 inches on the base, and 1 foot 8 inches wide on the face; it supports a trunnion saddle 4 feet 8 inches long, and 1 foot 8 inches wide for carrying the arm. The machine is driven by a five speed cone, taking a 4-inch belt, and by powerful double gear mounted on the saddle, and giving a range of 10 speeds. It is fitted with a base plate 11 feet long × 4 feet wide over all, and a movable table, which is employed mainly for small work. The second drilling machine is much smaller, but is, in many respects, similar to the one described. It drills at a radii of 5 feet 6 inches down to 1 foot 10½ inches. The arm, which will rise or lower 2 feet 3 inches, is self-acting, and will swing completely round the supporting pillar. It has a 2½-inch spindle, balanced in a different manner to the large drill. There are a greater number of motions provided in this machine. There is a fast motion for drilling, slow motion for tapping and boring, and quick reversing motion for withdrawing the tap, also releasing motion to allow the spindle to follow the tap, and the motion for moving the saddle along the arm; these, it may be mentioned, are all arranged upon the saddle. The machine stands upon a planed box table, 6 feet 2 inches long × 3 feet wide and 2 feet 6 inches high, and has planed T-slots on both sides. It is driven by a five speed cone taking a 3½-inch belt, largest speed, 1 foot 5 inches diameter, and fitted with overhead motion and the necessary screw keys and handles.



Radial Drill (Campbells & Hunter).



Geared Slotting Machine (Muir & Co.).

Another of our illustrations shows a self-acting sliding, surfacing, and screw-cutting lathe, made by Messrs. Muir & Co. The operations of this machine are performed by a back-shaft, with quick-hand traverse along the bed by rack and pinion. On this machine there is provided a top slide rest with full swivel, indexed for turning cones' surfaces, &c. A fast head-stock is provided, arranged with 24 changes of speed, which can work through single speed or single or double gear by a four-speeded cone of large diameter. The machine tool which is, perhaps, receiving the most attention at the present moment, is the milling machine.

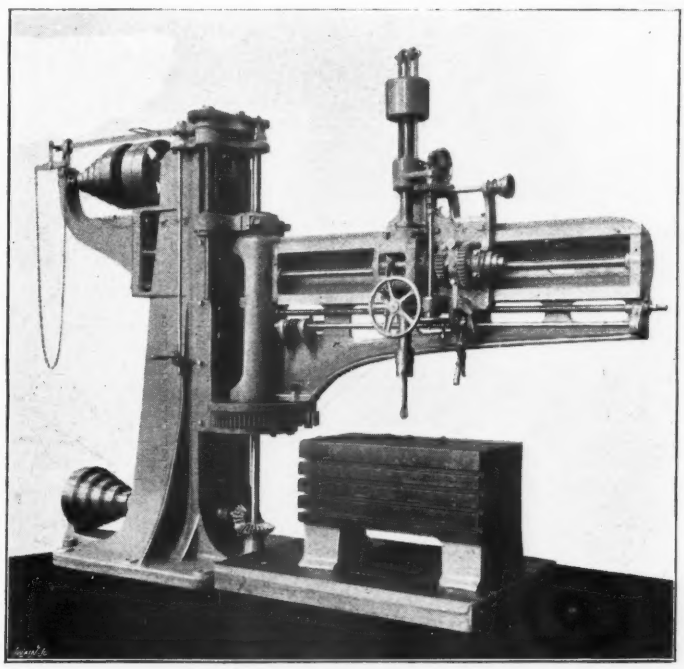
Mr. Samuel Nixon, in a recent paper on the milling machine, says:—

"In reviewing the development of milling, it will assist us very much if we bear clearly in mind the great cardinal principle of milling, viz., the employment of a small battalion of cutting edges, each prepared to relieve the other in rapid succession, so as to avoid the fatigue of any single one, as compared with the employment of a single-cutting edge, which shall have to bear the whole brunt of the work without any relief, until it is entirely overcome or used up.

"It is upon this idea of employing a battalion of cutting edges in the machining of any surface, and how to employ

them to the greatest advantage, that the whole element of design in milling machines has turned during the last few years, and so rapid has been this development, that a few years ago machines of 2 or 3 tons weight were considered heavy milling machines, whilst to-day machines of 10, 15, 20, and even 30 tons weight are becoming common."

In many of the older electrical factories, the milling machine is not, perhaps, very much in evidence yet, but we may be sure that our electrical contractors will not be slow to avail themselves of new designs if there is any possibility of gaining efficiency. We were especially struck with a horizontal pillar milling machine, which had been supplied to Messrs. Parker by Messrs. Muir & Co. The structure of this machine includes an independent box framing, which is arranged as a cistern for containing the lubricant. There is also provided a crosshead and adjustable stay for supporting outer end of mandrels for cutters, as well as a headstock with double gear and large cone pulley, having steel spindle running in conical hard gun-metal bearings. A patent coupling readily secures and releases mandrel to spindle. In addition, there is a rotary pump, fittings, and connections, for lubricating the cutters with soap and water. A strong table with vertical traverse, adjustable to the thousandth of an inch, by index plates, and fitted with self-acting longitudinal slide in line with the spindle, having adjustment to the thousandth of an inch. There is also a transverse slide to swivel, having table top with T-grooves, it being also provided with self-acting and self-stopping arrangements.



Radial Drill (Campbells & Hunter).

There is also at Messrs. Parker's an example of Muir's geared slotting machine. As will be seen from the illustration, the upright and bed are in one casting, and are of strong box pattern. There is a compound circular table with worm-wheel, self-acting in the circular, transverse and longitudinal motions. The slides and circular table are fitted with arrangement for locking in any position required. The vertical tool slide or ram is balanced, and works in a long continuous bearing, adjustable for taking up the wear, having quick return motion by improved link motion. The stroke of the ram is easily adjusted on the disc, which is indexed for the different lengths of stroke. It is driven by large cone pulley, fly-wheel and double gear, fitted at right angles to the frame. The arrangement of driving gear permits the man working the machine to fix his tool with one hand, and adjust it to the right position by the fly-wheel with the other hand, as well as enabling the machine to be placed in line with other machines, therefore saving much floor space. The feed motion is continuous, and can be varied without stopping the machine.

THE EVOLUTION OF THE HIGH-SPEED ENGINE.

An exceedingly good article on this subject appears in *Electricity* (New York) from the pen of Prof. R. H. Thurston. It is characterised by great moderation of tone, and while hopefully expounding and even extolling the principle of high speed, does so with due recognition of the limitations which are set upon it by practical facts, over which, as yet, engineers have not obtained full control. He lays down, first, that there have been three principal lines along which improvement of the steam engine has travelled since the days of Newcomen, "the inventor of the steam engine," and Watt, "its greatest improver," and these three lines are as follows:—

1. Increase of pressure.
2. Increase of ratio of expansion.
3. Increase of piston speed and speed of rotation.

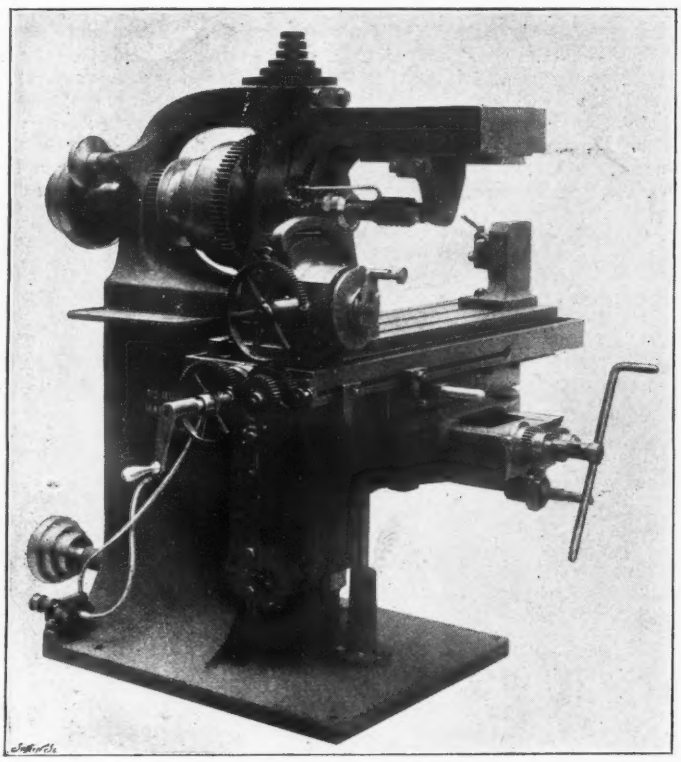
Of these, the first two are necessary, by increasing the thermo-dynamic effects—the efficiency of the machine as a heat engine. The third is advantageous as reducing the waste of heat within the engine, still serious, and at one time constituting the main expenditure of heat in the engine. Incidentally, also, the increase of speed reduces external wastes arising from radiation and conduction by reason of the ability given to a small engine to perform the same work as a larger and slower machine. These same factors also reduce cost by enabling a given weight of material to do work in a small space that formerly required a larger weight in a larger space; thus the Corliss engine, when invented, and with a cylinder 20 inches × 48 inches, ran at 40 revolutions per minute, and developed at non-condensing about 125 H.P., with 50 or 60 lbs. pressure of steam. To-day, the high-speed engine supplies the same power, with a cylinder 12 inches by 15 inches, and makes 250 to 275 revolutions, with 90 to 100 lbs. pressure. Half or a third of the steam was wasted by cylinder condensation in the older engine, the newer engine wastes but two-thirds as much, and the new engine weighs 6 or 7 tons, against 10 tons of the older engine, and would not weigh above half if built on the same scale of strength—this latter, perhaps, a too roseate view.

Regulation is better also in the new engine. Against this comparison, however, has to be set the onward improvement of the old style of engine. It has doubled or even trebled and quadrupled its speed, and it still excels the high-speed engine in steam economy. The high-speed engine is more exposed to disaster from water in the cylinder or loose parts, but less so from over speed, which seems to be a failing with large engines in America, probably because they have not generally adopted the knock-off motions almost universal in English practice.

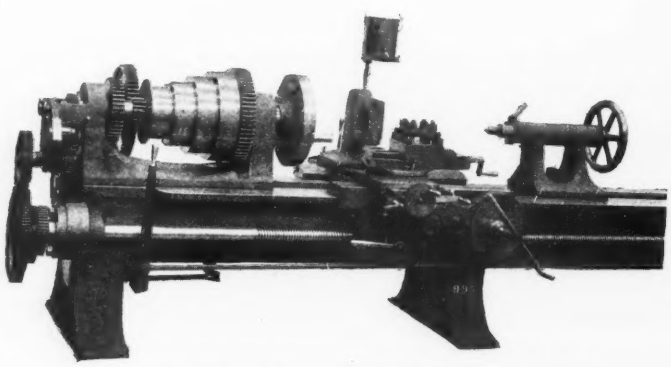
Practically the first two directions of gain must be followed together. Higher pressures must accompany higher expansion ratios. This is an axiom the neglect of which soon showed the necessity for the co-operation when engineers attempted to secure gain from increased expansion, and soon found that the gain became a loss. Marine engineering shows this progress of pressure and expansion perhaps more steadily than land practice, for the gain arising from economy is felt doubly at sea, every ton of weight saved in machinery or fuel furnishing so much of paying space, so that we might almost say marine progress has simply been

all that boiler makers could render possible. It has, we would say in short, been a record of furnace tube strength. Our author predicts pressures of 300 to 400 lbs. by the beginning of the next century, and limits the advance only by the approach to temperatures beyond the ability of our materials of construction to withstand. At the current rate of progress it will be a century before we reach the pressures employed experimentally with perfect safety and economy by Perkins 50 years ago. In 40 years, the diagram which shows the past century's progress, promises us 27 atmospheres.

Perkins, as far ago as 1824-36, used first 500 lbs., then 1,000, and, finally, 1,500 lbs. steam pressure, and he expanded only eight fold, and still obtained a H.P. for less than 2 lbs. of coal per hour. Measured by the old system of duty expressed in millions of pounds per bushel of coal, where Newcomen secured 5,000,000, Watt at once obtained 12, and then 20 and 30. His Cornish successors secured 60 to 70, and the early compounds 100, while recent pumping engines obtain 130, and even 150 millions. These figures correspond with a reduction of fuel consumed from 40 lbs. per I.H.P. hour to 2 lbs. with the early compounds of 1865. Latest figures correspond with 1¼ lbs. Equally, of course, with the pressures, ratios of expansion have progressed from 2 to 20, and the highest ratios still fall far below what thermodynamic considerations would indicate; the reason being that the theoretical gain becomes overweighted by the increasing losses of the engine itself in friction and internal wastes. It is these losses, or the latter of them, that the present tendency to the employment of superheat is calculated to reduce, as well, also, as is the third direction of progress, in the way of increased piston speed and rotation. This, of course, is a direction along which it has only been possible to travel just so fast as purely workshop methods have allowed us to do, for it has been in workmanship and in a better understanding of the mechanical principles underlying the action of an engine as a complex system of dead and moving masses, that progress in the third degree has been possible. We think, however, that the learned writer has placed too much stress on the three dimensions of his space. There is a fourth dimension, and that lies in the plane of more perfect working fluid. High pressure steam is no more perfect a fluid than low pressure; indeed, it may be described as less so in practice, because it so soon loses some of its high temperature heat. By a more perfect, one would understand a more truly gaseous fluid, such as superheated steam is known to be. It is to-day, we fancy, in this direction, rather than in that of merely mechanical speeds, that economies are to be attained and improvements secured. Of course, as pointed out by the author, the higher the ratio of steam to the mass of an engine, the smaller will be the waste due to conduction and radiation and cylinder effects, and the lighter smaller engine will, or should, cost less to build and house, it will run more steadily, and generally call for less weight of material all round, and will, therefore, lose less by the friction of the main shaft, which is the chief friction of every well designed and constructed engine. This is the hopeful view of the high speed engine, against which is to be set its greater cost in repairs, and the losses incidental to stoppage for repairs.



Vertical Milling Machine (Muir & Co.).



Sliding, Surfacing, and Screw Cutting Lathe (Muir & Co.).

In order to explain why the high speed engine does not attain all that might be expected from it, a table is given showing the principal consumptions and wastes of an engine 6 inches by 8 inches at 280 revolutions when run with pressures of 75 lbs., increasing by 20 lbs. to 155 lbs.

Taking the extreme pressures, and an expansion of 16, the chief results are respectively as follows:—I.H.P., 3·1; 8·9; ideal steam per I.H.P., 15·85; 10·98; internal waste coefficient, 1·234; 1·234 giving waste, 19·56 and 13·55 per I.H.P. hour. External waste per I.H.P. hour, 3·3; ·836; total wastes, 22·86; 14·336; total consumption, 38·71; 25·36. The high-speed engine uses about two-thirds the steam of the low-pressure per I.H.P., but if for each pressure the engine is run with the most economical ratio of expansion, that for the lower pressure will call for four expansions only, and will do 11·77 I.H.P., while the higher pressure will perform a duty of 16·2 I.H.P. on eight expansions, and the steam consumption in the two conditions will be now 27·887 and 23·03, the higher pressure now requiring about six-sevenths as much steam per H.P. hour as the smaller pressure. The improvement becomes very slow as pressures advance, and are very soon converted into losses whenever the maintenance is

allowed to fall ever so little below high water mark; and again, we would point to the greater gain to be now secured from improving the fluid than from improving pressures and speeds. Reverting to the question of boiler pressures and the fact that Perkins handled pressures of 1,500, and even 2,000 lbs. with no special trouble, Mr. Thurston states that at Sibley College there has been constructed in the College workshops a water tube boiler, tested at 1,350 lbs., without a sign of weakness, and used to drive an engine at 300 to 600 lbs. pressure, and he looks forward to the pressures of 1836 becoming standard in the future.

The limit attained in practice would seem to be the Sibley College engine, of quadruple expansion type, recently built in the college workshop, and operated as a high speed engine at 500 lbs. of steam or upward. It is claimed to have developed a horse-power with less than 10 lbs. of steam (11,000 B.T.U.). It has been worked at 620 lbs. pressure, and at a speed of 500 revolutions, with no foundation bolts or other confining arrangements. All the valves are independently adjustable, and there are reheaters between each successive pairs of cylinders, which permit of maximum heat utilisation and extinguish cylinder condensation, the reheaters forming comparatively low temperature surfaces to absorb waste heat from the flue gases, and affording an illustration of the use of the wrong thermo-dynamic principle of applying heat to the working body not at maximum temperature. This little engine is cited as a most satisfactory corollary of the technical teaching afforded in the college. It is simply a four-crank open front vertical engine, of what we may term the electrical type, or modified marine type.

Though of only 20 horse-power, it has apparently excelled all previous records; but, after all, it is not so far ahead of certain large pumping engines, and we should be disposed to credit much to the reheating system.

While we must award every praise to this exceedingly well written article of Prof. Thurston's, we cannot avoid the feeling that, after all, it forms a very powerful argument in favour of moderate speeds and pressures, and is an excellent treatise in brief upon the limitations imposed by practice upon advances along purely theoretical lines.

BUSINESS NOTICES, &c.

Electrical Wares Exported.

Week Ending July 28th, 1895.	£	s.
Alexandria. Teleph. mtl.	54	0
Amsterdam	75	0
Barcelona. Teleg. mtl...	29	0
Bombay...	170	0
Brussels...	48	0
Buenos Ayres	63	0
Canea. Teleg. mtl. ...	24	0
Cape Town	54	0
Colombo	48	0
Delagoa Bay	23	0
Demerara	31	0
East London	605	0
Fremantle. Teleph. mtl.	45	0
Helingsforo. Teleg. cable	554	0
Jersey. Teleg. cable ...	65	0
Madras	39	0
Melbourne	283	0
,, Teleg. wire	998	0
Port Natal. Teleg. mtl.	34	0
Sydney	290	0
Stockholm. Teleg. mtl.	195	0
Shanghai. Sub. cable...	950	0
,, Teleg. mtl.	15	0
Singapore	15	0
Suez. Teleg. mtl. ...	67	0
Victoria, B.C. Teleg. cable	60	0
Total	£4,834	0

Week Ending July 28th, 1896.	£	s.
Alexandria. Teleph. mtl.	32	0
Amsterdam	370	0
Barcelona. Teleg. cable	390	0
Berbric	11	0
Boca	43	0
,, Teleg. mtl. ...	151	0
Brisbane. Teleph. mtl.	150	0
Bombay...	411	0
Brussels	22	0
Buenos Ayres	462	0
,, ,, Teleg. mtl.	211	0
Cape Town	27	0
Christiana. Teleg. wire	43	0
Colombo	123	0
Durban	218	0
Fremantle	243	0
,, Teleg. mtl.	293	0
Gothenberg	550	0
Hong Kong	13	0
Kurrachee	18	0
Malta. Teleg. mtl. ...	111	0
Marseilles. Teleg. mtl.	17	0
Melbourne	12	0
Monte Video	348	0
Ostend	27	0
Port Elizabeth	60	0
,, Said	8	0
Rangoon	62	0
Rio Janeiro. Teleg. mtl.	820	0
Rockhampton	324	0
Rosario	1,258	0
St. Petersburg	8	0
Santos	25	0
Shanghai	183	0
Singapore	80	0
Stockholm	45	0
Sydney	32	0
Wellington	2,283	0
Yokohama	320	0
Total	£9,804	0

Assistants Wanted—South Shields.—According to an advertisement in our columns, three switchboard attendants are required at the South Shields Corporation Electricity Works.

Callender's Bitumen Telegraph and Waterproof Company, Limited.—At an extraordinary general meeting of the above-named company, held at the offices of the company at No. 90, Cannon Street, London, on Wednesday, July 8th, 1896, the following special resolution was duly passed, and at a subsequent extraordinary general meeting of the members of the said company, also held at the same place on Thursday, July 23rd, 1896, the following resolution was duly confirmed, viz.:—"That it is desirable to reconstruct the company, and accordingly that the company be wound up voluntarily, and that Henry Drake and David Painter McEwen be and they are hereby appointed liquidators for the purposes of such winding up."

Catalogues.—Messrs. Moody Brothers, have sent us their catalogue, which embraces gas and oil engines, dynamos, storage batteries, and switchboards.

From Messrs. Roberts Brothers, Dukinfield, comes an illustrated list showing the various types of fuel economisers which they make.

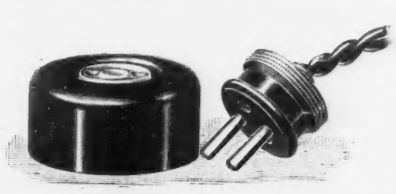
Mr. Hugo Krieger, 3, Hornstrasse, Berlin, sends us a catalogue of Geissler, Crookes, and other forms of vacuum tubes, induction apparatus, and incandescent lamps.

Messrs. J. Bagshaw and Sons, Limited, Batley, have favoured us with an illustrated price list of wrought iron pulleys, shafting, and friction couplings. Some interesting and useful information is given on the subject of transmission by ropes.

Messrs. Connolly Bros., Limited, have sent us a copy of their new catalogue. The list is very complete, reliable, and handy of reference. The size has been considerably increased, and includes higher qualities of insulation, concentric cables, lead and iron sheathed cables, cotton and silk covered wire, bell and telephone wires, &c., tables of reference, a handy telegraph code, and an index of contents.

Cruto Incandescent Lamp Agency, Limited v. New and Mayne.—In the City of London Court, on Tuesday, the plaintiff company sought to recover the sum of £12 3s. for electrical goods supplied to the defendants, electrical engineers, Palace Chambers, Bridge Street, Westminster. Mr. Bingley, counsel for the plaintiffs, said that the defendants carried on business in a large way, and had a branch office at Hull. The plaintiffs received an order purporting to come from the defendants' Hull branch, and it was signed by their manager. The manager gave the plaintiffs considerable orders, and a telegram was received from them, as well as several letters on their letter paper, in reference to the goods under order. The plaintiffs supplied the goods and gave credit, as they supposed, to New and Mayne. When the plaintiffs applied for payment of their account, they were told by the defendants in London that they had disposed of their Hull branch 12 months before to their late manager, and that if he had gone on using their paper, &c., it was not their (defendants') fault. Mr. Whateley, defendants' counsel, said the defendants could not possibly be held liable for the acts of their manager after he had ceased to represent them, and after he had, in fact, taken over the business from them. They gave their manager three months' notice to terminate the agency, and when that expired he took over the business. Then he gave the plaintiffs the orders now sued upon, and in their names. They knew nothing of the matter, and, having had nothing to do with the goods being ordered, they could not be saddled with the liability. Mr. Bingley argued that, if the defendants knew that their manager was using their paper after he had taken the business over, and they allowed him to do so, they would be responsible for his acts. Mr. Whateley agreed that if they could be shown to have known it they might be held liable. But that was just what they did not know. Mr. Waterman, the assistant secretary in the plaintiff company's service, stated that it was on August 23rd that he received the orders in question from Mr. Fitzmorris, who, he understood, represented the defendants in Hull. He knew the defendants as large electrical engineers, with a branch at Hull. No notice was sent to them by the defendants or any one else that they had parted with their business to their late manager, and they did not see any intimation to that effect in the *London Gazette*. He produced the "Electrical Trades Directory" for the present year to show that the defendants were still purporting to carry on the branch business at Hull. Mr. Whateley said there was nothing to show that the defendants had authorised any notice to appear in the directory produced, which, of course, was not evidence. Mr. Commissioner Kerr said the plaintiffs could not get over the fact that the defendants themselves had never ordered the goods which were being sued for. That being the case, there must be judgment for the defendants, with costs.

"Dot" Wall Socket.—Mr. A. P. Lundberg is making an exceedingly neat and simple wall socket, which he calls the "Dot."



The plugs and sockets are made interchangeable, and there are no metal parts at the back in connection with the circuit.

Gas Again.—An escape of gas occurred during repairs at Garratt Lane School, Wandsworth, and in the search for it an explosion took place, injuring a man and a child.

Messrs. Parker, Limited.—The *Birmingham Post* says that the works of Messrs. Parker, Limited, Wolverhampton, are to be considerably enlarged.

Orders for Brockie-Pell Lamps.—Messrs. Johnson and Phillips have received the following orders for Brockie-Pell lamps, 90 for Hammersmith, 59 for Durban (Natal), and 36 for Chester.

Outing.—On Saturday last, the principals of Messrs. Williamson & Joseph, Limited, having had a very good run of business during the past few months, determined that the staff should enjoy themselves. They consequently issued invitations to a dinner at Hastings, where excellent arrangements had been made. After a comfortable dinner Mr. Joseph, in an eloquent and fervent address, which was not too lengthy, expressed the hope that the company would all meet again for a similar festival next year. The whole party were then conveyed in carriages to Bexhill and back. After tea, and having spent a most enjoyable day, the South-Eastern Railway reconveyed the party express to Cannon Street.

Tudor Accumulators.—Mr. A. B. Pescatore, the manufacturer of Tudor accumulators, has sent us a circular and catalogue, from which we extract the following:—Owing to an important improvement in the manufacture of Tudor plates, there have been considerable reductions in the prices; this is especially the case for stationary cells discharging at 3 to 10 hours' rates, where the reduction in price is fully 15 per cent. The plates are of the same system as those supplied hitherto, and have the full capacity specified in the catalogue. Their durability is in no way diminished; the rates of maintenance are reduced in the same proportion as the prices, *i.e.*, they remain at 3½ to 6 per cent. of list price, and at the same time the guarantee given with all batteries is extended to two years. The new types of portable cells have now been perfected in all their details, and Mr. Pescatore is prepared to supply them for every purpose; the type known as P.E. has been especially designed for tramways, the extremely high rate of charge, viz., 20 minutes, allows of the cells being charged at the end of each journey, without removing the batteries from the cars. Much labour is saved, and the weight of cells to be carried is also greatly reduced by this method. We need hardly say, from a traction point of view, this is very important, and our readers will watch with interest the developments that will no doubt take place.

ELECTRIC LIGHTING NOTES.

Battersea Municipal Buildings.—At the meeting of the Vestry last week, the Electric Lighting Committee's report upon the tenders which were submitted for the electric lighting of the Municipal Buildings was brought up for consideration. In response to the invitation, 35 tenders were received, and upon the recommendation of the consulting electrical engineer, Mr. Robert Hammond, the following have been accepted by the Vestry, subject to the respective contractors entering into contracts with two sureties for the due and satisfactory execution of the work:—

	£	s.	d.
Section A.—*Boilers and Accessories.*			
Messrs. Spurr, Inman & Co., Limited	668	10	0
Section B.—*Engine-House Plant.*			
Messrs. Johnson & Phillips	1,030	15	0
Section C.—*Main Switchboard and Instruments.*			
Messrs. Laing, Wharton & Down	143	0	0
Section D.—*Accumulators.*			
The Chloride Electrical Storage Syndicate, Limited ..	314	0	0
Section E.—*Wiring and Fittings.*			
Mr. A. H. Wood, Westminster	1,042	13	6
	£3,198	18	6

The Vestry passed a resolution giving the Committee power to carry the scheme into effect, and having regard to the urgency of the matter, the Vestry has been authorised to enter into the necessary contracts for the execution of the work. It was decided that application be made to the London County Council for a loan of £4,200, in lieu of the sum of £3,000 previously sanctioned by the Vestry for the purpose of defraying the cost of the work.

Bermondsey.—The vestry are going to approach six of the leading electrical engineers as to advising the parish on the subject of electric lighting. No doubt some electrical engineers will approach the Vestry.

Coventry.—The Coventry City Council have had under consideration the advisability of embarking upon the public lighting of the streets. Councillor West submitted a motion giving the Electric Lighting Committee power to that effect, and supported his case with the opinion of Mr. Hammond, the Corporation's consulting electrical engineer, who adduced a number of reasons in favour of local authorities, who had electric lighting works, adding public lighting to their undertaking. The cost Mr. Hammond estimated at from 1½d. to 2d. per unit. It was proposed to replace 13 100-C.P. and 35 15-C.P. gas lamps with 22 800-C.P. electric arc lamps, the relative cost per annum being £396 for the electric light against £217 11s. 9d. for gas, the return in illuminating power being 17,600 C.P. by the electric light as compared with 1,885 by gas. The Council, before whom the motion came on Tuesday, rejected it, although favouring an experiment with a few lamps in the centre of the city.

Cheltenham.—A Siemens alternator, driven by a Belliss engine of 170 H.P., has been added to the lighting plant.

Church Lighting.—The Tayler-Smith Electric Company have secured the order for lighting St. Mildred's Church, Bread Street.

Darfield.—The Urban Council are considering the question of lighting the streets with electricity.

Exeter.—The City Council has had under consideration a report from the Special Committee on Electric Lighting. The Town Clerk had been instructed to communicate with the officials concerned in reference to a supply of electricity for Exeter Post Office. The Committee recommended that the following tenders be accepted:—Alternators: Messrs. Easton, Anderson & Goolden, Erith, £1,320; transformers: the Brush Electrical Engineering Company, three of 30-kilo-volt capacity and four of 10-kilo-volt capacity, £300; boiler: Messrs. Babcock & Wilcox, the water-tube boiler of 300 horse-power, 140 lbs. pressure, £630; cables: Fowler-Waring Cables Company, 3,650 yards of cables, £685. It was explained that the total amount to be expended was £3,490, including fixing of machinery, &c., making, with the £7,500 already laid out in purchase of works, £10,990. The loan asked for was £11,000. The report was adopted by the Council.

Electric Lighting in Russia.—It is reported that the municipal authorities of Sebastopol have decided to light the public streets by electricity.

Edinburgh.—An estimate of Mr. John Lowrie, amounting to £4,397 for additions and alterations to the electric lighting works, has been accepted.

Finsbury Circus.—At the recent meeting of the Commissioners of Sewers Mr. Hudson submitted a report from the Streets Committee stating that, as soon as the question of minor street lighting by electricity was settled, special attention would be given to the question of improving, if necessary, the lighting of Finsbury Circus.

Hammersmith Want an Engineer.—The Vestry is advertising for a resident engineer, to be paid £200 during the construction of the works, and £250 after completion.

Hull.—The Finance Committee of the Corporation are considering the question of borrowing £42,000 for electric lighting extensions.

Johannesburg.—It is said that some of the streets are to be lighted by electricity.

Leith.—The Town Council has resolved to apply for a provisional order.

Limerick.—Professor Kennedy has examined the water-power of the Shannon for electric lighting purposes, but does not favour it. In his report to the Corporation he recommends that works be constructed at the present gas works costing £9,800. Plans are to be prepared for a system of 4,000 lamps.

Music Hall Lighting.—The directors of the Edinburgh Music Hall have just spent over £2,000 upon decorations and introducing the electric light. The electrical work has been carried out by Messrs. King and Co., Leith, to the specification of Mr. A. A. Campbell Swinton.

Paisley.—Mr. F. Teague, of Coatbridge, has been appointed resident engineer to the municipal authority.

Redditch.—The Urban District Council has resolved to apply for a provisional order.

St. Pancras.—Chalk Farm Road, Kentish Town Road, Great College Street, Pancras Road, and Gray's Inn Road are to be lighted by electricity.

Sunderland.—The Electric Lighting Sub-committee of the Sunderland Corporation estimate that their expenses for the half-year ending March 31st, 1897, will be £2,216 7s., and the total revenue £2,526 3s. 4d., showing a credit balance of £309 16s. 4d. In the corresponding half of last year there was a debit balance of £450. For the three months ending June 30th last the output was 15,609 Board of Trade units, and £302 10s. 6½d. was received.

The Difference.—The highest tender submitted for the wiring of the Shoreditch power station was £956, and the lowest £428.

West Ham.—Mr. Risch having resigned the position of electrical engineer to the Town Council, on the grounds of ill-health, Mr. J. J. Steinitz, of Leicester, has been appointed in his place.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

An Electric Railway Carriage on Fire.—The daily press announce that at Budapest on Friday last one of the carriages on the underground electric railway, containing six passengers, exclusive of the two railway employés in charge, suddenly took fire as it was travelling rapidly, and there was nothing to do but to quicken the speed and reach the terminus. The flames gained ground, and the car was totally destroyed soon after it reached the end of the journey. The passengers escaped with a terrible fright, but the employés were shockingly burnt. It is supposed the fire was due to some defect in the electrical apparatus.

Dover Trams.—The Bill has received the Royal assent.

Electric Traction in Germany.—The authorities of the Berlin-Charlottenburg tramways are reported to have decided to adopt electric traction on its lines. The accumulator system is to be adopted, the batteries being of the Schafer-Heinemann type. The construction of an electric tramway between Hilden and Dusseldorf has just been decided upon.

Leeds Electric Tramway.—It will be remembered that the Tramways Committee of the Leeds Corporation last month accepted a tender of Messrs. Crompton & Co., of Chelmsford, for trolley wires and attachments for the sum of £3,370. This tender was afterwards withdrawn, and at a meeting held three weeks ago, the committee resolved to accept the tender for the work of Messrs. Siemens, London, at the sum of £5,620. That firm has also withdrawn, and the committee has decided to recommend the Council to accept the tender of Messrs. Laing, Wharton & Down, London, the amount being £5,740.

Work has been already commenced on the new electric tramways.

Southampton Tramways.—An expert is to be retained by the Corporation to report on the suitability of the present tramway permanent way for electric traction, also on the desirability of using overhead or underground wires.

Stockton.—It is said that the Stockton Tramway Company will adopt electricity in place of steam. The present cost per car mile is over 9d.

TELEGRAPH AND TELEPHONE NOTES.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (1869, Anglo)	April 6th, 1895 ...	...
Puerto Plata-Martinique ...	Dec. 19th, 1895 ...	...
Monte Alegre-Santarem ...	May 5th, 1896 ...	...
Bissao-Bolama	May 30th, 1896 ...	...
Lourenço-Marques-Durban ...	July 13th, 1896 ...	July 25th, 1896.
Shanghai-Nagasaki	July 23rd, 1896 ...	...
Gibraltar-Tangier	July 28th, 1896 ...	...
Landlines.		
Trans-Continental line beyond Mazol (Mashonaland)	March 12th, 1896 ...	...
Bolinao-Manila	March 19th, 1896 ...	...
Communication with Cartagena and Barranquilla, Columbia.	July 4th, 1896 ...	...
Communication with Cuenza, Machala, Santa Rosa, Laja, and Guaranda	July 10th, 1896 ...	...
Siberian lines Werkhne Oudinsk-Tschita	July 21st, 1896 ...	July 24th, 1896.
Communication with Quito and other places in Ecuador beyond Guayaquil	July 24th, 1896 ...	July 26th, 1896.
Saigon-Bangkok	July 26th, 1896 ...	July 27th, 1896.
Cheik Said-Hodeida (Yeman)	July 27th, 1896 ...	7uly 28th, 1896.
Moulmein-Bangkok	July 28th, 1846 ...	...

A Cable to Hayti.—The New York *Evening Post* says the United States and Hayti Telegraph and Cable Company, capitalised at $1,800,000, was incorporated with the Secretary of State on July 15th. The general route and points to be connected are:—From New York City to Coney Island, or some other point on the coast of this State, thence by submarine cable to the Island of Hayti in the West Indies, as well as from New York City through the States of Connecticut, Rhode Island and Massachusetts to Boston and other parts and places on the coast of Massachusetts. The directors are: Albert B. Chandler and Edward C. Platt, of Brooklyn; John W. Mackay, George Clapperton, Albert Beck, Charles E. Merritt, and John Beattie, of New York.

CONTRACTS OPEN AND CLOSED.

OPEN.

Armagh.—August 3rd. The Commissioners for the Control of Lunatic Asylums, Custom House, Dublin, want tenders for the erection of an electric light installation for the Armagh Asylum. Particulars from the secretary.

Germany.—July 25th. Tenders are being invited for the supply and erection of the plant and fittings required for the electric lighting of the railway station at Bretten. Tenders to the General Direction of the Grosse-Badische Staats-Eisenbahnen, Carlsruhe.

Halifax.—The Guardians of the Halifax Union are asking for tenders for electric lighting and hoists, for a new infirmary to be erected at Skircoat, Halifax. Intending contractors are to send their names, on or before August 13th, next, to Messrs. Horsfall and Williams, architects, George Street, Halifax.

Hapton (Padiham, Lancs.).—August 3rd. Tenders are wanted for lighting Hapton township with electricity from September 1st, 1896, to April 30th, 1897, for the Parish Council. Endorsed tenders to be sent to Mr. E. O'Shaughnessy, clerk, St. Anne's Terrace, Padiham, by August 3rd. Full particulars can be obtained on application to the clerk.

Harlow (Essex).—August 3rd. Tenders are asked by the Harlow Lighting Committee for the following—viz.: (1) for lighting with gas or other light the district from September 1st, 1896, to April 20th, 1897, inclusive. Further information from Mr. J. Cowlin. Tenders to be addressed and sent to the Chairman of the Parish Council by August 3rd.

Madras.—Nov. 11th. Lieut. Col. C. C. Rawson (in charge Consulting Architects' Division) invites tenders for the lighting by electricity of Government House, Madras, including the banqueting hall and the A.D.C.'s bungalow: also for the lighting of Government House, Guindy, including the Military Secretary's bungalow. Particulars to be obtained on application to the Consulting Architect to the Government of Madras, Chepauk, Madras.

Manchester.—The Gas Committee are prepared to receive tenders for the construction of an underground electric lighting sub-station in Piccadilly. General conditions of contract, bills of quantities, and forms of tender, can be obtained on application to Mr. C. Nickson, Superintendent Gas Department, Town Hall, Manchester.

Mexico.—Sealed tenders will be received by the secretary of the City Council of the City of Mexico, not later than the last day of August of the current year, for the lighting of the city by electricity. All information and conditions of tender, plan of the city of Mexico, &c., can be obtained on application at the Mexican Consulate, Broad Street House, New Broad Street, London.

Russia.—Tenders are being invited until August 13th by the Municipal Authorities of Odessa, for the electric lighting of a portion of the suburbs of the town and also of the new prison.

Southampton.—August 10th. For the construction and erection of four electric cranes and accessories, and also for alterations to gantry of an existing crane, on the Town Quay, Southampton, for the Southampton Harbour Board. Specification, with two general drawings attached, may be obtained on and after 20th, inst. from Mr. A. H. Skelton, clerk, Town Quay, Southampton, upon payment of £3 3s., which will not be returned. Further details from Mr. J. G. W. Aldridge, 9, Victoria Street, Westminster, S.W.

Spain.—The Municipal Authorities of Arevalo (Avila province) are at present inviting tenders for the electric lighting of the public streets of the town under a 20 years' concession. Tenders to be sent to El Ayuntamiento de Arevalo (Avila).

Spain.—Tenders are at present being invited by the Municipal Authorities of Estepa (Seville province), for the concession for the electric lighting of the town during a period of ten years. Tenders to be sent to El Secretario del Ayuntamiento de Estepa (Seville).

Spain.—The Municipal Authorities of Nava del Rey are inviting tenders until August 29th, for the concession for the electric lighting of the town during a period of 20 years. Tenders to be sent to El Secretario del Ayuntamiento de Nava del Rey.

CLOSED.

Battersea.—Tenders for lighting the Battersea Municipal Buildings have been accepted. Details will be found under "Electric Lighting Notes."

Exeter.—The tenders which have been accepted for the extension of electric lighting at Exeter, are given in our "Electric Lighting Notes."

Shoreditch.—For the internal wiring and fitting up of the power station, Messrs. Laing, Wharton and Down's tender of £428 has been accepted.

City and Guilds of London Institute.—The Executive Committee of the City and Guilds of London Institute have appointed Mr. W. E. Dalby, since 1891 University Demonstrator of Mechanism and Applied Mechanics at Cambridge, to the Professorship of Mechanics and Applied Mathematics at the Institute's Technical College, Finsbury, rendered vacant by the resignation of Prof. Perry. Mr. Dalby served a seven years' apprenticeship in the locomotive works of the Great Eastern Railway, and gained a Whitworth Scholarship in 1883. In 1884 he entered the service of the London and North-Western Railway, graduated B.Sc. London in 1890, and in 1894 received the full degree of M.A. *honoris causâ* from the University of Cambridge.

NOTES.

The Recent Death from Electric Shock.—At the City Mortuary, on Thursday last week, Mr. Arthur Langham resumed the inquiry regarding the death of John Jackson Chisholme, aged 30, sub-foreman at the City of London Electric Light Company's works in Crosby Square, who was killed by an electric shock at the works on Thursday week.—At the previous hearing it was shown that the deceased was assisting to carry out some electrical tests at Crosby Square Station, as it was necessary to make St. James's Square Station "alive" from Crosby Square. Whilst taking the "inner conductor" out of the "terminus," the deceased (who, contrary to the rules, was not wearing gloves) received a shock which killed him a few minutes later. The jury returned a verdict at the last hearing, but withdrew it on learning from an uncle of the deceased that the latter had remarked, just prior to his death, "I am doing some work now over which I have no control, and if a 'certain man' is not properly attending to his work at St. James's Square Station, it will mean my instant death." James Robert Tillbrook, the person referred to by deceased as the attendant at St. James's Square Station, now attended. He visited St. James's Square Station (of which he alone held the keys) on six occasions on the day of the accident, but positively declared that he never did anything to make any of the mains "alive." He merely visited the stations to take readings of the supply of electricity to customers, as well as to see that the switches were in order, and to feel the secondary connections to see whether they had become warm or not.—By the jury: Witness was 21; had been in the company's employ three years, his wages being 30s. per week.—Mr. Bolton Aspinal, the superintendent of the company, recalled, said the deceased man's wages were 32s. per week.—A juror: And would he have to be a practical engineer for that wage?—Witness: A thoroughly experienced practical man.—The juror: It seems to me to be starvation wages (hear, hear from the other jurors). I am told the orthodox pay of a thoroughly competent electrical engineer, even where they have only to deal with bells, is 10d. per hour. How can this company expect to get competent men at their rate of pay? (Hear, hear.) Mr. Aspinal admitted that the insurance companies would not accept employés in the company's service except at the hazardous rate of premium.—Eventually the jury returned a verdict of accidental death, and added the following rider:—"We think the City of London Electric Light Company have not taken proper precautions to prevent their employés meeting with accidents of this character; we also wish to express our opinion that the men are not properly paid; and also that notices as to the dangerous nature of the work should be posted at every station." We fail to see why the question of pay should have occupied the attention of a worthy juryman, for it strikes us that double the wages would not have saved the poor victim. The censure and recommendations of the jury would have carried more weight had they strictly confined themselves to the inquiry into the cause of death. There are many highly trained and competent young engineers in central stations at home and abroad whose weekly wage does not extend to 32s., but even they cannot always guard against mishaps. It is curious that the intelligence of certain persons who suddenly became associated with matters of public interest cannot distinguish between artisans earning their 10d. per hour and men who are engaged upon special duties, even though the latter class may be receiving less pay. If pecuniary reward were any criterion of the value of work done, we expect some of the very gentlemen who are so ready to talk of starvation wages would find it difficult enough to make ends meet.

A Little Mistake.—A contemporary, writing on the 'Production and Utilisation of Ozone," has just stultified itself in a most remarkable manner in criticising Andreoli's ozonisers as being constructed against the accepted *canons*. He describes them as being without intervening dielectrics. How is it that the writer failed to notice that between each electrode Andreoli has a dielectric, and this dielectric is one of the essential features of his ozonisers?

Designing Railway Power Plant.—Perhaps the most severe test of the ability of a mecanical engineer who is engaged to design an electric railway power plant is his arrangement of the auxiliary appliances and the piping system. He has to lay out his plant so as (*a*) to avoid unnecessary length of piping, (*b*) to secure a duplication sufficient to keep the plant in regular operation, no matter what accidents may happen to individual parts, (*c*) to avoid difficulty with joints and escaping steam due to expansion, contraction, and other causes, (*d*) to make every portion of the plant easy of access, so as to provide for constant inspection and occasional repair, and (*e*) to do this all at minimum first cost. One of the chief requisites of a power station is absolute continuity of operation, and the necessity of duplicating such parts of the plant as are most liable to accident, and whose temporary disuse would otherwise paralyse the service, is apparent. In times past, engineers have adopted several widely different methods of duplication. Those most generally employed involve the constant use of one complete feeding system, and the holding of another in reserve to be used only in case of accident to the first. This means large pipe diameter in each system, and consequent heavy first cost, and may easily mean that the reserve system will be out of order when the necessity for its use is most urgent. Mr. Davis, in a recent number of the *Street Railway Journal*, describes the different methods of piping which have been employed in electric railway work, and recommends one which the editor of our contemporary considers to possess a number of advantages. The plan proposed involves the employment of two systems of pipes whose combined sectional area is equivalent to the area of a single main capable of operating the entire plant in the most economical manner. These duplicate systems are used together, and continuously—in parallel, as it were. If one system should break down it is immediately cut out and repaired, and, during the short period usually necessary for such repairs, the pressure on the boilers is raised a sufficient amount to make it possible to still deliver steam to the engines through the second system at the same pressure as before, though, of course, with a considerably greater temporary loss in the piping. In other words, Mr. Davis believes, and with reason, that a small reduction in the efficiency of the piping system, occurring at rare intervals and only for a day or two at a time, involves far less money loss than the constant loss of interest upon the much larger investment necessary with duplicate systems, each of which is capable of running the entire plant at all times. Several plants have been piped on this system, and are understood to be working with entire satisfaction and excellent economy.

Significant.—A letter in our correspondence columns, following one from "Spectator" in our last issue on the subject of celluloid in accumulators, is interesting for two reasons. The evidence given by Mr. Crompton in the trial of a recent libel action is mentioned, and on referring to the report of that case, we find the plaintiff saying:—"A cell which was constructed to a large extent of celluloid, was mechanically stronger than one of lead, because in acid the lead underwent chemical changes." The plaintiff also admitted that the three things essential for traction purposes were high capacity, mechanical durability, and light weight. Now we are told, on the authority of the Editor of *Lightning* (and he ought to know), that if the battery of which "Spectator" spoke "be the I.E.S., he should surely know that celluloid has been abandoned in its manufacture."

The Telephone Trunk Service.—Following similar operations in other parts of the country, the National Telephone Company's trunk telephone business in the South Wales district, and in Ireland, was transferred to the Post Office on Saturday afternoon last, July 25th. The transfer was carried out in South Wales without any special incident; but in Dublin there was a little delay in making the various connections, owing to a severe thunderstorm which broke over the town and district just about the hour fixed for the change. Messrs. Gavey and Cooper, of the Engineer-in-Chief's office, superintended the transfer operations in South Wales on behalf of the Post Office, and Messrs. Louth (Dublin), and Walby (Belfast), acted similarly in Ireland.

Institution of Electrical Engineers Students' Class.—Mr. G. C. Allingham, the hon. secretary of the Students' Committee, sends us the following particulars of the summer excursion to Switzerland. The party of students and their friends will leave London on the evening of Saturday, August 29th, and arrive at Bâle on the following evening. It is proposed to spend one day at Bâle, one day at Schaffhausen, three days at Zurich, one day at Lucerne, three days at Geneva. The party will probably leave Switzerland on Wednesday, September 9th, but arrangements can be made for any who wish to extend their visit beyond that date, as the railway tickets are available for 25 days. Arrangements can also be made to return by steamboat down the Rhine, which would take about two days, and would cost about £2 10s. extra. Students who are already in Switzerland can join the party at Bâle. Mr. Webb is endeavouring to obtain permission for the students to inspect a number of the most important electrical works and installations in Switzerland, including the following:—The Maschinenfabrik Oerlikon; Messrs. Brown, Boveri and Company's works; the wire-rope and electric power transmissions at Schaffhausen; the Stanserhorn and Mont Salève Electric Mountain Railways; Messrs. Escher, Wyss and Company's turbine works; the two great water power plants at Geneva; the Geneva Exhibition. There are still a few vacancies in the party.

Erratum.—In the article on "Alternate Current Motors" in our last issue, page 121, fig. 26 should be as below:—

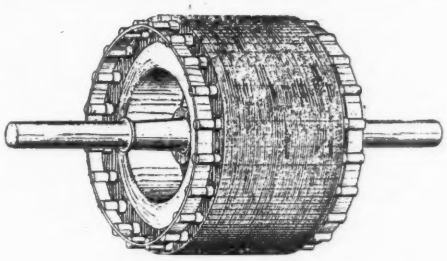


FIG. 26.

Personal.—Mr. Basil R. Baker, of Messrs. Swete and Baker, Johannesburg, is leaving South Africa for England by the R.M.S. *Norman*, and expects to arrive here about August 1st, for the purpose of buying stock. We understand that he will be glad to hear from manufacturers who desire to be called upon for the purpose of introducing their specialities to South Africa. Mr. Baker's address in London will be Westminster Palace Hotel, Victoria Street, S.W.

Electric Light Machinery.—The Admiralty have placed with Messrs. Maudslay, Sons & Field, London, an order for two complete sets of electric light machinery. One set is intended for the *Magicienne*, now serving on the North American and West Indies station, and the other for the *Marathon*, on the East Indies station.

Inductance as a Negative Capacitity in Submarine Cables.—We omitted to mention that the article of Mr. A. Davidson on this subject, published in our last issue, was taken from the columns of the *Electrical Engineer* of New York. Our contemporary will, we are sure, forgive the unintentional omission.

P.Q. Atlantic Cable.—The Telegraph Construction and Maintenance Company's steamer *Britannia*, which left the Thames early this month to repair the Brest-Penzance section of the P.Q. Atlantic cable, has completed the repair and returned to London.

Willans and Robinson's Prolongation of Patent.—On Wednesday, before the Privy Council, consisting of Lord Watson, Lord Macnaghten, Lord Shand, Lord Davey, and Sir Richard Couch, the petition for the prolongation of letters patent granted to Peter William Willans, deceased, and Mark Heaton Robinson, dated October 14th, 1882, for an invention of "improvements in high-speed engines," was presented. Mr. Moulton, Q.C., Mr. Roger Wallace, Q.C., and Mr. J. C. Graham appeared for the petitioners, Willans and Robinson, Limited; the Attorney-General and Mr. Sutton for the Crown. The object of the invention was to control the moving parts—namely, the piston-rod and piston—of engines moving at high speeds, and it consisted in the use of a cylinder containing air, in which a piston moved which was connected to the heavy moving parts The Attorney-General admitted that the invention was one of merit, but contended that sufficient remuneration had been received in respect of it. Lord Watson intimated that their Lordships were unable on the materials before them to come to the conclusion that the remuneration received in respect to the patent had been inadequate, and they would accordingly advise her Majesty that the petition ought to be refused.

Success of Electric Traction at Bristol.—The gross receipts of the Bristol Tramways and Carriage Company for the past half-year amounted to £54,456, working expenses and renewals to £42,810, and net revenue to £11,646. A dividend at the rate of 6 per cent. per annum is proposed, and £2,410 is placed to leased premises redemption, electrical renewals, and contingency accounts. The St. George and Kingswood electric line has been worked to general satisfaction, and it is intended to apply in the ensuing Session of Parliament for powers to use electricity on the other portions of the undertaking.

Electrical Inspector, or Engineer.—Mr. Voysey, City Electrical Inspector, thinks that his duties warrant him being designated "electrical engineer," and he has written to the Commission of Sewers to that effect, which body will deliberate on the matter. It will be seen from our report of the City accident, that the popular idea of an electrical engineer is not altogether an exalted one, for one of the jury said he was told the orthodox pay of a thoroughly competent electrical engineer, even when they have only to deal with bells, was 10d. per hour.

New Lighthouse.—Next year the construction of a new lighthouse on Arcona, which is to be provided with an electric light, will be commenced. The new lighthouse is to be built on the south side of the existing tower, and is to have a height of 52 m., while the old one is but 25 m. high. The present light is much complained of by ship-masters and pilots, who maintain that in thick, not foggy, weather they have often seen the flash light at Hiddensee, lying more to the eastward, much sooner than the fixed light of Arcona.

Crypto Specialities.—We have received a catalogue of the well-known specialities of the Crypto Works, Limited. They are chiefly small dynamos and motors that are illustrated, all of which seem excellently designed. On one occasion we had the pleasure of using small Crypto dynamos and motors at a lecture, and their performance was most excellent.

Explosions in the City.—The Streets Committee of the Commission of Sewers are to consider whether the risk of explosion in the transformers and other boxes connected with the electric light supply might not be minimised by certain means which were in operation elsewhere.

Marriage.—The *Scotsman* records that Mr. Alfred E. Mavor was married to Dorothea, youngest daughter of Luke A. Ionides, at the Parish Church, Dartford, Kent, on the 22nd inst. Tyred of cycling alone we suppose.

NEW COMPANIES REGISTERED.

James Dilks & Co., Limited (48,812).—Registered on July 17th with a capital of £20,000 in £1 shares, to enter into an agreement to carry on the business of printers, lithographers, stereotypers, electrotypers, embossers, photographic printers, &c. The subscribers (with one share each) are:—W. Burrows, Luknow Road, Nottingham, printer; D. McCaig, 4, Herbert Street, Nottingham, clerk; T. G. Mellors, King John's Chambers, Nottingham, accountant; T. N. Coles, 13, Postern Place, Nottingham; E. H. Bridges, 47, Palm Street, Nottingham; A. E. Hawksley, 42, Victoria Road, Netherfield, Notts, clerk; B. W. Allen, 13, Park Terrace, Nottingham, solicitor. The number of directors is not to be less than two nor more than seven. The first are to be appointed by the subscribers; remuneration as the company may decide. Registered by Ashwell, Browning and Euton, 30, Ely Place, E.C.

CITY NOTES.

The National Telephone Company, Limited.

Mr. James Staats Forbes presided at the meeting of this company, held yesterday at Cannon Street Hotel. After noting the increase in the business, the Chairman said the time would arrive when they could hardly expect the increases to be in the same proportion. The working expenses had increased by £18,622, which was one of the least favourable items in the report. The net result was an increase of £42,150, with which they were fairly satisfied. They had received £438,321 in advance for rentals, which was a measure of the progress of the business, and was indicative of what the position would be at the end of the year. They recommended dividends on the same scale as last year, though there was a larger amount carried forward. The increase in the capital expenditure, which they would note was unavoidable on account of the outlay in connecting subscribers. They had erected 5,699 additional wires, against 4,257 in the corresponding year. A good deal of the outlay was due to the substitution of the metallic circuit. They had spent in Manchester £45,000 for the construction of underground work. They had induced some of the municipal authorities to permit them to go underground, and this not only improved the efficiency of the service, but provided greater capacity, which the overhead wires did not. He then went through various items in the capital account. They were spending in Dublin, Leeds, Birmingham, London, Bradford and other places £205,000 on land and buildings, but as they practically only used the roofs, they could let the rest at very respectable tenancies. He thought this a very satisfactory use to make of the reserve. When they next met the metallic circuit in London would be nearly complete. With regard to the transfer of the trunk lines to the State, they had made the best bargain they could, and they were satisfied with the result. In conjunction with the Post Office authorities, they were doing their best for the public, but the difficulties they anticipated were already happening. He contrasted the difference between London and the provinces in the way of obtaining facilities; they had numerous subscribers who could not be supplied with service for the want of wayleaves. He next referred to the proposal of the company to establish a pension fund for the benefit of the staff, and thought shareholders would approve of the scheme. They had filled the vacancy which existed on the board by electing Sir James Fergusson, a former Postmaster-General, to a seat on the board. After some further remarks he moved the adoption of the report, which was seconded by Lord Harris, and after some discussion adopted.

The retiring directors and auditors were then re-elected, which closed the business of the meeting.

Anglo-American Telegraph Company, Limited.

The Marquis of Tweeddale presided, on Friday last, at a meeting of this company, held at Winchester House. In moving the adoption of the report, the Chairman observed that the notable feature in it was the increase of £11,917 in the traffic receipts, as compared with those of the corresponding period of the previous year. This was no doubt owing to the revival in trade; and when the Presidential election was over, and the financial policy of the United States was placed on a more stable basis than it was at present, they might confidently anticipate an increase in commercial enterprise. The expenses of the head office and the stations again showed a decrease on balance of £533. On the other hand, there had been an increase of £1,644 in the repairs of cables—not in connection with their deep-sea lines, but with the shorter cables in low water between Newfoundland and the coast. These had now been put into thoroughly good condition. The renewal fund now amounted to £651,700, but the market value of the stocks held was, he understood, about £100,000 more than that, taking the investments at the middle price. They were, therefore, making tolerably rapid progress towards the £1,000,000 which they had so often talked about in connection with their renewal fund. He thought they might consider that they had come through the ordeal of the International Telegraph Conference satisfactorily. With reference to the litigation respecting the French cable, they would remember that the directors appealed from the decision of the French Court, which was favourable to them to a certain extent, but not sufficiently so. The company's case was lodged last April in the Chamber of Requests of the Court of Cassation, or final Court of Appeal. The Chamber had the power of refusing to allow an appeal. The documents lodged had to be examined by the official reporter to the Chamber, and afterwards by the Advocate-General, with whom it rested to give notice when he was ready to bring on the case for hearing. The consideration of the papers rested entirely with the officials of the Court, and nothing the company could do would expedite the hearing. The result of their operation for the half-year was the considerable increase in their dividend of 3s. per share.

Mr. F. A. Bevan (deputy chairman) seconded the motion.

Some of the shareholders expressed dissatisfaction at the chairman also occupying a similar position on another similar company, and asked some questions on the French case.

The Chairman, in reply, said he felt sure they would be able to recover the costs incurred by them in connection with the French litigation, but the object of their appeal was to recover a much larger sum. He considered that it was quite compatible with the interests of this company that he should be chairman of the Eastern Telegraph Company also. There were intimate relations between them, and the fact that he was on both boards would tend, he believed, to smooth any friction which might arise between them. Neither the Eastern Company nor the pooling companies had any interest in promoting a cable to America by the Azores. The concession for the German cable was originally very different from what it was now. They would hear nothing of it, he believed, for some years to come, with the exception of the opening of the line from Germany to Spain, and this was entirely with a view of giving the Germans better communication to the East than they at present had. The directors regarded the renewal fund as of vital importance to their undertaking. Practically, a compromise was come to some years ago with the shareholders that the renewal fund should be increased to £1,000,000, and that any surplus balance should then be devoted to revenue purposes. He could assure them that the directors earnestly desired to arrive at the time when they would be in a position to give something to the deferred stockholders. It must not be forgotten that when the sum mentioned was fixed upon as a *minimum*, their cables were many years younger than they were now. One of the cables, it was true, was comparatively new and strong, but the others were old, and they must look forward to the time when it would be necessary to renew them or to put in many miles of new cable. Their share in the pool depended on their maintaining three cables for certain, and if anything happened to disable for any considerable period two out of their four cables they would lose enormously out of the pool receipts. When Governments took to subsidising cables in competition with those working on commercial principles it was a serious matter, but they could not prevent the French Government or the German Government from giving subsidies.

Messrs. Crompton and Company, Limited.

The annual meeting of this company was held at the City Terminus Hotel, last Friday, Mr. John Trotter occupying the chair.

The Chairman said he had a rather difficult task in addressing them on the affairs of the company, as probably most of them knew more about the past of the company than he did. They had happened to fall upon a particularly bad year, occasioned by the fire in November last. As was shown in the report, the effect of that fire was to destroy all the books and records in the offices at Chelmsford, and it had been found impossible to prepare any profit and loss account this year. The only feasible plan was to prepare a fresh valuation and make a fresh start. That had been done, and the results of the valuation were set forth in the statement of accounts. As there was no profit and loss account, it was rather difficult to compare the present state of affairs with the past years before the fire. The fire had destroyed a large portion of stock and electric lighting plant, and the only comparison he could show them was from certain figures under the property and assets side of the balance-sheet. As compared with those of last year, they would see that freehold property was taken at £12,780, plant, tools, &c., at £38,999, making a total, together, of £51,779. These figures were arrived at after having the freehold property carefully valued, and the plant and tools had been valued by Mr. Crompton and Mr. Brunton, who had spent a great deal of time in preparing the estimate. Taking that figure of £51,779, and adding to it the amount of insurance applicable to that particular item, £25,585, they obtained practically £78,000. These two items last year stood at £70,197. They had, since the fire, spent upon restoring these things the sum of about £7,000. If that were deducted from the £78,000, there remained £71,000 represented by freehold property, plant, tools, &c.; therefore there did not seem to have been any serious loss directly due to the fire. The insurances had been properly kept up, and a fair amount was recovered, which left their property about the same value. But the indirect loss through the fire had been very serious indeed. The cost of manufacturing was increased, and the cost of providing temporary power created very grave additional expenses, and the effect of that was clearly shown in the balance-sheet in the £10,051 which they might fairly say was directly traceable to the results of the fire. They had, however, learnt several lessons from the fire. It had been made clear to them that the Chelmsford lighting must be kept distinct from the manufacturing business, and it was also clear that works of more than one storey were not suited to their requirements, which seemed to tend in the direction of heavy machinery. The directors, after going carefully into the matter, concluded that it was absolutely necessary that new works should be established as speedily as possible. After making most careful surveys, they were fortunate enough to secure a site near Chelmsford, so near to the railway, that it was possible to have a railway siding into the works, which would make an immediate saving in the cost of transport; they were on as high ground as could be obtained in the neighbourhood of Chelmsford; there was also an excellent water supply. The works were being arranged so

that extensions would be easy, the offices were separated from the works, so that there was little danger of the records being destroyed as they were in the fire. It so happened that the works were, previous to the fire, busier than they had been for a long time before; indeed, an era of prosperity had apparently dawned upon the company. He was pleased to say that orders remained very numerous, quite as many as the company could execute. Every effort was being made to concentrate the business of the company, and to get rid of outside excrescences as much as possible. The branch at Hove had been sold on very advantageous terms. The cooking department, on which a considerable sum of money had been spent, had been reorganised, and the expenditure of money upon it checked, and it appeared to the board as if they had got a property that may prove very advantageous to them. Efforts were being made to get rid of the branch at Lillie Bridge, in order to concentrate the business at Chelmsford. Mr. Albright had been out in Australia to get the business there more in hand. The board had been pressing forward the manufacturing engineering business abroad and at home, especially at Birmingham, where there was a good solid business to be done in the manufacturing portion of the company's work. There were several items in the report which he should like to see dealt with, such as the non-realisable assets, and it would be a good thing if they were taken in hand. The Chelmsford Lighting and other subsidiary companies were, as far as he could ascertain, good companies; but in some instances they were non-dividend paying, and some rectification ought to be applied to them. Then there was the suspense account, and there was a rather large item for patents; then there was goodwill £30,000, and revenue account £10,000; altogether these made up a very considerable amount, and if they, the shareholders, were of the same way of thinking, it would be a good thing to try and arrange some scheme by which they might write a portion of these off. Some of them did not want much, but the suspense account ought to be dealt with. He had no definite plans to propose, but he hoped the board would be able to formulate some scheme which would be equitable to all the interests concerned. He then moved the adoption of the report.

Mr. CROMPTON, in seconding the resolution, said how much they owed to the splendid efforts of the staff on the occasion of the fire. Up to the time of the fire they had been doing very fairly well, and it was a most bitter disappointment to find all their efforts swept away just as things were improving.

The motion was then put to the meeting, and carried. The retiring directors were then re-elected, and other formal business transacted.

City and South London Railway Company.

THE half-yearly meeting of the shareholders of this company was held on Tuesday last, at Winchester House, Old Broad Street, Mr. C. G. Mott presiding.

The report having been taken as read, the CHAIRMAN, in moving its adoption, said he was glad to say that during the past half-year the company had maintained that safe and punctual working which had characterised the railway from the beginning, and which he hoped would continue. There was no doubt that, so far as their experience had gone, there was no railway in existence that could boast of more punctuality, convenience, and safe working than theirs. Turning to the accounts, he said that dealing first with the capital, they had during the half-year issued £3,000 of preference shares, and £7,530 of debenture stock. They had received £3,780 premium on the issues, making a total receipt of £14,310. They had spent in various new works, additional rolling stock, and improvements, £3,280; they had paid off £8,400 of terminable debentures; they had an increased balance at their bankers of £964, and they had reduced their outstandings by £1,666. Those items together made up the £14,310 which they had received on capital account. They would notice in the statement of capital authorised that there was a considerable change since the last report. That arose from the fact that at the last meeting they created the capital under the Act of 1893, and consequently it had added very largely to the authorised figures, although not to the amount issued. As regarded the revenue, the receipts from passengers showed an increase of £328; there was a small decrease in season tickets of £17, and a small decrease in transfer fees of £3; but there was an increase in parcels of £30, in rents of £156, and in sundry receipts of £15, making a net increase of £509. The expenditure showed a net decrease. The maintenance expenses showed an increase of £130, which was due to their having charged £150 of the cost of altering the King William Street station against revenue. They had doubled that station and increased the accommodation very much, and the auditors thought that a portion of the expense should be charged against revenue; £150 had, therefore, been so charged, which accounted for the increased maintenance expenses, which would otherwise have shown a reduction. The expenses of the locomotives and the generating power showed a decrease of £253, carriage repairs an increase of £108, traffic expenses a decrease of £40, general charges an increase of £11, passenger duty a decrease of £59, law charges a decrease of £5, while the rates and taxes, as usual, had increased this half-year by £90. That made a net decrease on the whole expenditure of £18. That, he thought, they would agree with him was very satisfactory, for, while they had increased their revenue, they had decreased their expenditure. It was not often a railway company could show such a state of things, and therefore it must be regarded as very satisfactory. Their net increased receipts were £509, and the net decreased expenditure £18, making £527 to the good. On the other hand, the balances at their bankers had not been so large, and they had received £18 less on that account, which left them with £509 only to the good. They had decreased debenture interest of £299, but they had an increased preference dividend of £182, showing a decreased expenditure on those two items of £117, which made them £626 to the good. They proposed to declare an increased dividend of ¼ per cent., which would cost £707, and they proposed to do it by using the £626 net increased receipts, and to take £147 out of the balance brought forward in the previous half-year. Although they had taken that £147 from the previous balance, they carried forward £100 more than they did at the corresponding period last year. Their working expenses during the half-year had been 60·02, against 61·55 in the corresponding half-year, so that they had decreased those expenses by 1½ per cent. In order to get a proper comparison with other railways, it was necessary to deduct the cost of working the lifts, and if they did that the working expenses this half-year had been 51⅜ against 52 per cent. in the corresponding period last year. The receipts per train mile were 2s. 2½d., against 2s. 2⅛d., showing $\frac{7}{10}$d. improvement. The receipts per passenger were 1·87d., against 1·82d. in the corresponding six months of last year. The receipt per passenger last year was the largest they had had since they had charged the uniform fare of 2d., with which they commenced. The locomotive expenses per train mile had been, during the past half-year, 5·80d., against 6·10d. in the corresponding six months of last year, which showed a steady decrease. If, in order to make a comparison with other railways, they deducted the cost of the carriage of coal, which they had to pay, the rate per train mile was reduced to 4½d. The number of passengers carried last half-year was the largest number since June, 1894. At that time, in consequence of the overcrowding of the line, they raised their fares very considerably, and in the half-year ending June, 1895, the numbers fell to 3,113,000. That number had since considerably increased, and last half-year it reached 3,192,000. That was very satisfactory, for, notwithstanding the increase in the fares, the number of passengers using the line was steadily increasing. The receipts from the 3,192,000 passengers last half-year were £24,021, whereas the receipts from the largest number of passengers ever carried in any one half-year—in June, 1894, when they carried 3,333,000—was only £23,500. That showed that although they had carried less passengers than they did two years ago their receipts were nearly £500 more. That distinctly showed that the traffic on the line was making steady and regular progress, and that notwithstanding the raising of the fares. They might, therefore, look forward hopefully to a large accession of traffic when they got their extension opened. In order to carry the additional traffic last year they had had to run considerably more trains, and the alterations at King William Street had enabled them to do that. They had completed the new locomotive that had been built in their own works, and it was now working very satisfactorily, and their new coaches were at work also. He told them last year that they contemplated putting down a condensing plant in order to save in their fuel consumption. That work was making very satisfactory progress, and he hoped that in the course of the next two or three months it would be ready for work. It was a very large erection, and the work had had to be done very carefully, because to some extent it was a novel mode of treating fuel in this country; but they had every reason to believe that the erection would work very satisfactorily when completed. The shareholders would naturally like to know what was being done in regard to extension to Moorgate Street. They had to get three station sites, one of which had been secured, and negotiations were nearly completed for the acquisition of a second. The third site was that of the church of St. Mary Woolnoth, and they had been put to a great deal of anxiety and trouble over that, caused from the fact that their opponents were continually changing their minds. First they wanted the church pulled down, and then they wanted it preserved. The matter was still before Parliament, and he hoped that it would be satisfactorily settled in the course of a few days. At the last meeting the shareholders gave them power to issue 20,000 £5 preference shares for the purpose of paying for the extension. Those shares had been issued on satisfactory terms. At the last meeting he was under the impression that those shares could be made to rank *pari passu* with the existing preference shares, but they found, on inquiry, that they would have to rank after them, and that of course made it much more difficult to place the shares. However, they had all been taken up, and they would not bear interest until 2½ years from the present time, by which time they would have time to complete the line. Tenders had come in for the extension, and they were in the hands of the engineer at the present time; but owing to the unavoidable delay which had taken place, he was sorry to say that the original estimate would be slightly exceeded.

Mr. SAMPSON HANBURY seconded the motion.

Mr. DRAKE congratulated the directors upon the satisfactory character of the report, and said that the little advance in the dividend was very satisfactory, coming as it did in a half-year which, owing to the prevailing heat, was not unduly favourable to underground traffic.

Mr. JEFFREYS said he was sorry to see the decrease in the season tickets; he should rather have expected an increase in that direction.

The CHAIRMAN said that the real reason for the decrease in the season tickets was that two years ago they raised the rates very considerably, and in consequence many of their passengers preferred to pay every day, and gave up their seasons. It was satisfactory to know that they had not lost the traffic, for, on the whole, the season tickets had increased considerably during the last few years. The new preference shares had been taken up by a few wealthy persons—the directors thinking that a better policy than offering them to the general mass of shareholders.

The report was then adopted.

The full dividend of 5 per cent. upon the preference shares, and a dividend at the rate of 1⅜ per cent. per annum upon the ordinary shares was then agreed to.

The CHAIRMAN, in reply to a vote of thanks for presiding, said that he and his colleagues would continue to do their best to make the prosperity of the line a real and accomplished fact.

The Chili Telephone Company, Limited.

The report of the directors states that the aggregate number of subscribers at all centres at the end of the year was 4,252, as compared with 4,015 at the beginning, or a gain of 237 for the year. The gross revenue from all sources for the past year compares favourably with that of the previous one:—In 1895-6 it was $619,826; in 1894-5 it was $555,551; an increase of $64,275. The expenditure in Chili during the year was $384,979; in the previous year, $364,477; an increase of $20,502. The net income in Chili from all sources was in 1895-6, $234,846; in 1894-5, $191,074; an increase of $43,772. The average rate of exchange for the year was 17·27d., as compared with 13·61d. in the previous year, giving an increase for the year of 3·66d. Converted into sterling at these rates, the figures given in the preceding paragraph are: In 1895-6, £16,903; in 1894-5, £10,835; an increase of £6,068. The liquid assets and liabilities in Chili on March 31st, 1896, were valued of 17¼d., the current rate of exchange on that day, as compared with 16⅝d., at which they were valued on the corresponding date of the previous year. The increase in the value of the liquid assets over liabilities in Chili, due to this rise in exchange, amounts to £351, which has been carried to reserve. The expenditure in London is £61 more than in the previous year, mostly due to additional income tax. The net profit of the whole business was in 1895-6, £8,551; in 1894-5, £6,013: an increase of £2,538. In addition to the amount mentioned in paragraph 7, the sum of £3,295 has been carried to the reserve account, raising it to £15,500. The directors recommend the payment of a dividend of 4s. per share, being at the rate of 4 per cent. per annum, leaving £557 16s. 1d. to be carried forward to next year's account. During the year the capital outlay in sterling was £3,833, and the total mileage was on March 31st, 1896, 6,722 miles 269 yards; on March 31st, 1895, 6,420 miles 80 yards; an increase of 302 miles 189 yards. The Hon. Ernest Allsopp, having taken up his residence abroad, has been reluctantly compelled to resign his seat on the board, a position he has capably filled since the formation of the company. His brother, the Hon. Herbert Allsopp, has been elected to fill the vacancy. In accordance with the articles of association, the Hon. Herbert Allsopp retires from the board of directors, and, being eligible, offers himself for re-election. The auditor, Mr. Thomas A. Welton, also retires and offers himself for re-election.

The Edison and Swan United Electric Light Company, Limited.

The thirteenth annual report for the year ending June 30th, 1896, states that the profit and loss account, after writing down considerable amounts for depreciation of plant and stock, shows a credit balance of £27,526 12s. 9d. Providing for the interest accrued upon the £100,000 debenture stock, there remains a balance of £23,026 12s. 9d. available for distribution. An interim dividend at the rate of 5 per cent. per annum having already been paid in respect of the first half-year ending December, 1895, a further payment, at the rate of 5 per cent. per annum, in respect of the second half is recommended; the balance of £5,352 14s. 9d. being carried forward. Notwithstanding the severe competition now existing in the trade, the volume of business during the past year has been larger than in any former period; but the increase in the cost of material and labour, the lowering of the sale prices of many articles, and the check to the company's manufacture consequent upon the strike at the Ponder's End Works in the early part of the book year, have necessarily somewhat adversely affected the results of the year's working. The final meeting for winding up the Swan United Electric Light Company, Limited, was held on December 17th, 1895, and the liquidation thereby completed. Major Flood Page and Joseph Wilson Swan, Esq., F.R.S., retire by rotation from the board, and offer themselves for re-election. Messrs. Welton, Jones & Co., the auditors, offer themselves for re-election.

Direct United States Cable Company, Limited.

The ordinary general meeting of this company was held on Tuesday at Winchester House, Mr. E. M. Underdown, Q.C., presiding. The Chairman said that the revenue for the half-year ended the 30th ult. had been £42,456, while the working and other expenses, including income-tax, but excluding the cost of cable repairs, had been £19,692. The net profit for the half-year had thus been £22,764, which was increased by the amount brought forward to £26,913. This had been or would be appropriated by the payment of two dividends of 2s. 6d. each, £7,500 has been transferred to the reserve fund, and the amount carried forward was £4,235. Their revenue had continued to improve during the half year, and as compared with that of the corresponding period of 1895, an increase was shown of £4,803, or nearly 13 per cent. The expenses had naturally been higher, but only by £783, or 4 per cent. The balance of the reserve fund had thus been increased to £313,969—a figure, however, which represented the cost price of their investments, whereas their present market value exceeded the sum mentioned by about £64,000. He afterwards referred with great regret to the loss which had been sustained by the death of the late chairman, Sir John Pender. They were working with the utmost friendship and co-operation with the Western Union Company, and their relations with the Anglo-American Company were extremely satisfactory. Their relations with the Government were also satisfactory. Some years ago representations were made by their late chairman to the Colonial Office as to their not getting the messages from the Bermuda Company which they ought to receive, according to the terms under which that company enjoyed a subvention from the British Government. An answer was given to these representations some years since by the Government, but he examined into the matter, and did not consider the reply satisfactory. He was now glad to say that, after communicating with the Government and the Admiralty, he believed they would in future have their proper share of the messages in question. It was unnecessary to go back to the agreements originally made between the company and the other Atlantic cable companies. They had only one cable against a total of 11, and taking all things into consideration, the share they had of the traffic was a very satisfactory one. With reference to the question of the reserve fund, respecting which he had received letters from some of the shareholders, their cable was getting respectable from its age. It had held out in a remarkable way, but they must be prepared for contingencies. In order to retain their share in the pool, they must have a perfectly good cable, and they ought not to be contented until their reserve fund amounted to a sum which would replace their cable if it were to break down. He was glad to say that their traffic in the current half-year still continued to show improvement, and he hoped they would be able gradually to work up to something like their former prosperity.

Mr. James Pender, M.P., seconded the motion.

After some discussion, the motion was unanimously adopted, and a resolution was afterwards passed expressing sympathy with the family of Sir John Pender in their bereavement.

The Globe Telegraph and Trust Company, Limited.

The Marquis of Tweeddale presided at the ordinary general meeting of this company, held at Winchester House on Tuesday last.

In his opening remarks, the Chairman referred to the death of Sir John Pender, the late chairman of the company, and to the fact that he (the Marquis of Tweeddale) had been appointed chairman in his place. The increase in receipts of something over £5,000 was due to the fact that they had received better dividends from the companies in which they were interested. As was mentioned in the report, some changes were being made in the payment of interim dividends, the reason being that one of the companies in which they held investments paid its dividends a week later, and on two occasions they had to borrow money; but by the present arrangement the interest on this money would be saved. Referring to the various investments of the company, the chairman said that the Anglo-American Company had paid higher dividends, and as their holding was very large, a small increase naturally made a considerable difference, the increase being £4,760, and they would be glad to learn that the dividend just declared was higher than the corresponding period last year. The improvement in the Anglo Company's receipts were being maintained. During the year they had reduced some of their holdings and have reinvested. After referring at some length to the various other investments of the company, the chairman said the position of the Trust was never higher than it was to-day, the market value of the securities showed an enormous increase over the purchase value. He then moved the adoption of the report, which, after a little discussion, was carried.

Callender's Cable and Construction Company, Limited.—This company has been formed to purchase, as a going concern, the business of the Callender's Bitumen Telegraph and Waterproof Company. The capital is £100,000, in £5 shares, all of which are taken by the vendors in payment of the purchase price. £90,000 in 4½ per cent. first mortgage debenture stock has been issued, £40,000 of which is allotted in exchange for debentures of that amount in Callender's Bitumen Company, and £50,000 has been offered to the public.

The Cambridge Electric Supply Company, Limited.—The directors announce an interim dividend at the rate of 4 per cent. per annum for the half-year ending June 30th, 1896. The revenue returns for the half-year show a sale of 92,682 units, and receipts of £2,644 17s. 9d., against 67,223 units and £1,964 3s. for the corresponding period of last year.

The Charing Cross and Strand Electricity Supply Corporation, Limited.—Letters of allotment and regret for the issue of 10,000 4½ per cent. preference shares of £5 each at par were posted to the various applicants for the above shares of this corporation. We are informed that the issue was subscribed for nearly four times over.

The Westminster Electric Supply Corporation, Limited.—The board have declared an interim dividend for the half year ending June 30th, at the rate of 6 per cent. per annum, payable on September 1st next.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending July 26th, 1896, were £813; week ending July 28th, 1895, £827; decrease, £14; total receipts for half-year, 1896, £3,488; corresponding period, 1895, £3,421; increase, £67.

The Liverpool Overhead Railway Company. The receipts for the week ending July 26th, 1896, amounted to £1,301; corresponding week last year, £1,197; increase, £104.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending July 24th, 1896, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,695.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation, July 22nd.	Closing Quotation, July 29th.	Business done during week ended July 29th, 1896. Highest.	Lowest
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	4 %	100 —104 xd	100 —104	101	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	9 — 10	8½— 9½	...	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 11s.	£2 2s.	£2 9s.	50 — 52	50 — 52	51⅝	51
2,993,560£	Do. do. 6 % Pref.	Stock	£5 2s.	£4 4s.	£4 18s.	94½— 95½	96½— 97½	97½	94⅞
2,993,560£	Do. do. Defd.	Stock	...	...	...	9 — 9½	9 — 9½	9½	...
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% §	7 %	...	15½— 15¾	15½— 15¾	15¾	15⅜
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	5 %	112 —116	112 —116	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	... §	2½%	4 %	3½— 4	3½— 4	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	160 —170	160 —170	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % §	1½%	1½%	1/16— 3/16 xd	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12½— 13½	12½— 13½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	20 — 21	20 — 21	20¼	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3½— 4½	3½— 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	10 — 10½	10 — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	4½%	4½%	107 —110 %	107 —110%	...	...
60,710	Direct United States Cable, Ltd.	20	2⅝% §	2 %	2¼%	9⅜— 10¼	9⅜— 10¼	10⅛	10
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½%	6½%	17⅜— 18¼	17⅜— 18¼	18¼	17 13/16
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 %	6	18½— 19	18½— 19	...	...
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5 %	106 —109	106 —109	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4 %	131 —134	131 —134	133	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	17⅜— 18¼	17⅜— 18¼	18¼	18
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5 %	100 —1 4	100 —104	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5 %	101 —104	101 —104	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	132 —135	132 —135	...	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5 %	100 —104	100 —104	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5 %	101 —104	101 —104	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4 %	106 —109	106 —109	103½	107
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	111 —114 %	111 —114 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅝% §	4½%	4½%	11 — 11½	11¼— 11⅜	11⅜	11⅛
180,042	Do. do. 6 % Pref.	10	6 % §	6 %	6 %	17⅜— 18¼	17⅜— 18¼	18¼	17 13/16
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	8⅜%	10 %	23½— 24½	23½— 24½	24¼	...
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	105 —108	105 —108	105	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	53 — 55	53 — 56	54½	54
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	6 %	111 —114	111 —114	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 %	5½%	7⅜— 7⅞	7⅜— 7⅞	7 13/16	7¾
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	17 — 19	17 — 19	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	16 — 17	16½— 17½	17½	17⅜
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6⅞— 7⅛	6⅞— 7⅛	...	...
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	107 —110	107 —110	108¼	107½
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	4¼%	5 %	⅜— ⅞	⅜— ⅞	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	108 —111	108 — 111	...	...
11,839	Reuter's Ltd.	8	0 %	*nil*	5 %	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	137 —142	140 —145	...	...
58,000	United River Plate Teleph., Ltd.	5	...	3 %	4 %	3⅜— 4¼	3⅜— 4¼	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	101 —106	101 —106	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	*nil*	*nil*	4 %	6 — 7	5 — 6	...	...
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	104 —107	104 —107	...	...
30,000	West Coast of America Teleg., Ltd.	10	*nil*	*nil*	*nil*	1 — 2	1 — 2	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	8 %	99 — 104	99 —104	...	...
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	3 %	3 %	8⅜— 9½	8⅜— 9½	9½	9
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6⅞— 7½	7 — 7½	7½	...
33,129	Do. do. do. Def. Ord.	7½	...	1 %	1 %	2¼— 2⅝	2¼— 2⅝	...	...
165,200£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	6 %	105 —109	105 —109	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	6 %	105 —109	105 —109	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅛%	⅛%	⅛%	1⅛— 1⅜	1⅛— 1⅜	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11½— 12	11½— 12	11⅝	11½
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	9½— 10½	9½— 10½	10⅛	10 1/16
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	108 —111	108 —111	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7 %	110 —115	110 —115	...	...
164,300£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6 %	104 —107	104 —107	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	4½%	5 %	8¼— 8⅜	8¼— 8⅜	8¼	8⅜
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	7⅜— 8¼	7⅜— 8¼	8	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	4½%	114 —116	114 —116	115½	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	5 %	5 %	14½— 15½	14½— 15½	15 5/16	15
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16½— 17xd	16½— 17½	17½	...
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	133 —137	133 —137	134⅜	...
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	...	...	*nil*	8½— 9½	8 — 9	8⅜	...
20,000	Do. do. do. 6% Pref., 40,001—50,000 ...	10	...	...	6 %	13½— 13¾	13½— 14	13 15/16	13 9/16
10,000	Do. do. do. iss. at 2 pm., £1 paid	10	...	...	...	... — ...	4½— 5½	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2½%	3 %	4 %	13½— 14	13½— 13¾	13 9/16	13½
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	119 —123	119 —123	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	1 %	2 %	10½— 11½	11 — 12	...	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	4½%	6½%	7½%	12 — 13	12 — 13	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9½— 10½	9½— 10½	...	...
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	104 —106	104 —106	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	4 %	5 %	7 %	11 — 12	11— 12	11⅜	11⅛

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

§ Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation July 22nd.	Closing Quotation, July 29th.	Business done during week ended July 29th, 1896. Highest.	Lowest
£0,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	5 %§	2½%	...	1 — 1¼	1 — 1¼	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 %§	3 %	...	1⅜— 1⅝	1⅜— 1⅝	...	...
125,000	Do. do. 4½ % Perp. Deb. Stock... ...	Stock	4½%	4½%	...	112 —115	112 —115	112⅞	112½
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	98 —102	98 — 102	...	...
9,104	Central London Railway, Ord. Shares	10	...	...	...	... ...	10¼— 11	10⅞	10⅜
207,649	Do. do. do. £2 paid	10	...	...	...	... ...	2⅛— 2⅛	2⅜	2 5/16
630,000	City and South London Railway	Stock	1½%	1½%	1 3/16%	45 — 47	45 — 47	47½	47
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	3 %§	*nil*	*nil*	2 — 2½	2 — 2½	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	7 %	5 %	5 %	1⅞— 2¼	1⅞— 2¼	...	...
17,139	Do. do. do. "A" Shares 01—017,139	5	7 %	5 %	5 %	3 — 4	3 — 4	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	...	4½%	4½%	103 —106	103 —106	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	...	1⅜— 1⅝	1⅜— 1⅝	1 9/16	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	2½— 3	2½— 3	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	*nil*	...	⅜— ⅞	⅜— ⅞	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	...	⅜— ⅝	⅜— ⅝	...	...
9,600	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	*nil*	10½%	10½— 11½	10½— 11½	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	6 %	8 %	17⅓ — 18½	17⅓ — 18½	17⅓	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	17½ — 18½	17⅓ — 18½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	4½%	109 —114	109 —114	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	10 %	10 %	21 — 23	22 — 23	23	22½
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	105 —108	106 —109	109	107
37,500	†Liverpool Overhead Railway, Ord.	10	1 %	1½%	2⅞%	13 15/16 — 14 1/16	13⅞ — 13⅞	13⅞	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	17⅞ — 17⅞	17⅞ — 17⅞	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	20 %	15 %	37 — 40	39 — 42	41	39½
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £6 paid ...	10	...	...	...	8 — 8½	8 — 8½	8¼	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
CROMPTON & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—8%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅞—6¼.
Electric Construction Corporation, 6 % Debentures, 103—106.
House-to-House Company (£5 paid), 4⅛—4⅜.
Do. do. 7 % Preference, of £5, 8¼—8⅝.
Do. do. 4½% Debentures of £100, 109—111.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 9¾—10¼; 1st Preference Cumulative 6 %, £5 (fully paid), 7⅞—8⅛.
London Electric Supply Corporation, £5 Ordinary, 1—1⅛.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 7¼—7⅜.

Bank rate of discount 2 per cent. (February 22nd, 1894).

POWER TRANSMISSION AT RHEINFELDEN.

THE power works at Rheinfelden, near Basel, as described by Herr Rathenau in a paper presented to late meeting of the Verband Deutscher Elektrotechniker, are for the purpose of utilising parts of the fall of the Rhine between Lake Beugg and the Rhine Bridge, a total of 21 to 25 feet, which, however, varies considerably with the state of the river, and only some 8 to 16 feet can be made available. This is done by means of a canal of a bottom width of 165 feet, leading water to a house containing 20 turbines, each of 840 H.P., and jointly capable of taking 12,400 cubic feet of water per second. They are of Francis type, with a double set of guides and vanes, and run at 55 turns per minute. They are direct coupled to three-phase generators, each phase having an output of 63 amperes at 3,800 volts, or 720 kw. in all, giving, at 80 per cent., a net output of 580 kw. They are excited by three rotary 150 H.P. transformers, giving continuous current to the fields. The revolving piece has a diameter of 5·74 m., and the shaft a diameter of 310 mm.

Current is to be supplied in an area of 12½ miles radius. The mains will carry a pressure of 6,800 volts direct from the generators, but as demand increases, it will be raised to 16,500, for sake of economy in working, by means of transformers, and there will be two systems of mains, one for power and one for light, so as to avoid unsteadiness of lighting. Bare conductors are carried by poles at 36 feet above the ground. Poles are spaced 44 yards apart. Current is carried at 580 amperes per square inch of section of conductor and the lamps receive 72 per cent. of the energy in the shaft of the turbine, while the efficiency of the motor circuits is a trifle less, being 68 per cent. only. The charge for light will be a maximum of 4·8d. per kw. hour, with a maximum discount for quantity of 80 per cent., which reminds one somewhat of tube makers' discounts from list prices. For industrial purposes the price is 1·9d. per kw. hour, but installing will be charged for. This will cost from 50s. to 160s. according to size.

Herr Rathenau gives for a year of 3,000 hours, the following figures of cost for different powers :—

Horse-power.	Steam engines.	Electricity.
5	£150	£40
100	£1,300	£855
1,000	£7,875	£5,500

The first cost is estimated to be £15 per brake H.P. at the turbine shaft, which if secured, is moderate indeed for a power using no fuel and likely to be easily kept in repair.

ALTERNATE CURRENT TRANSFORMERS.

BY DR. J. A. FLEMING, F.R.S.

Society of Arts Cantor Lectures. Lecture II., delivered January 27th, 1896.

(*Continued from page* 124.)

THE CONSTRUCTION OF THE TRANSFORMER.

IN the previous lecture we have examined the general facts connected with the action of the transformer, and we have next to consider questions of transformer construction. The three organs of a transformer being the primary and secondary circuits and the iron core, the constructive problem is reduced to winding these circuits on the core, and properly constructing that core to receive them. We will consider, in the first place, the manufacture of the core. This has to be built up of iron wire or sheet iron, so divided or laminated that eddy currents cannot be set up in it. If it were not for this lamination, the periodic change of induction taking place in the core would set up in the mass of the metal local electric currents which would dissipate energy. Mathematical investigation has shown that, for frequency of 100, or thereabouts, it is useless to make the iron—whether in the form of wire or sheet—less than $\frac{1}{100}$th of an inch in thickness, that is, about ¼ mm., and useless to laminate it all, unless the laminations are less than 1 mm. in thickness. You will find in the *Electrician*, Vol. 28, pp. 599 and 631, investigations by Prof. J. J. Thomson and Prof. Ewing, which deal elaborately with this matter. I have found that their rather complicated formulæ are not fitted for use in the workshop, but that they can, for all practical purposes, be replaced by a much more simple formula, which fur-

nishes all the necessary information for transformer core construction. In the case of good sheet iron, and for the range of induction usually employed in transformer work, which is not more than 3,000 or 4,000 C.G.S. units, that is to say, 30 to 40 microwebers per square centimetre, if we represent the eddy current loss in watts per cubic centimetre of the plates by a symbol, E; and if we call t the thickness of the plate in mils., that is, in thousandths of an inch, and if B is the maximum value of the induction per square centimetres in C.G.S. units, and n the frequency, then it can be shown that very approximately $E = \left(\frac{t\,n\,B}{10^8}\right)^2$. Although this is a hybrid formula, containing units of different kinds, and may be horrible to purists, it will nevertheless be useful in the drawing office, and we can simplify it still more if we reckon the maximum induction in webers, and call I this induction per square centimetre, then $E = (t\,I\,n)^2$. In some works it is the custom to reckon the induction per square inch, instead of per square centimetre, and the thickness of the plate in fractions of an inch. If t_1 is the thickness of the plate in inches, and B_1 the induction per square inch, and E_1 the eddy current loss in watts per lb. of plates, then $E_1 = \frac{1{\cdot}4}{10^{10}}\,t_1^2\,n^2\,(B_1)^2$. The general custom is to use plates for transformer construction of about ·014 inch in thickness, and the standard induction which is generally selected is 2,500 lines of induction per square centimetre, or 2,500 C.G.S. units. This is equivalent to 16,125 per square inch. Under these circumstances, by the above formula, it is shown that the loss in watts per pound of plates due to eddy currents would be ·07 watt; the frequency being 100. It may be noted that any increase of temperature as the transformer is worked, by increasing the resistance of the iron tends to diminish the eddy current loss. It will, therefore, be seen that by employing plates of a thickness not greater than 14 mils. eddy current loss is reduced to a very small amount. One point, however, to which your attention ought to be called is, that unless the iron plates are properly arranged, eddy current loss may exist in them, however thin they may be. If, either by reason of magnetic leakage, or any other disposition of the magnetic induction, lines of magnetic induction move through the iron in such a manner that their direction is not always parallel to the direction of the lamination of the iron, then, under those circumstances, eddy currents may be set up in the core, which are not hindered by lamination. This source of waste was present in many of the earlier forms of transformer. In addition to the loss of energy caused by eddy currents in the core, there is, of course, that other source of loss called the hysteresis loss, which is due to the magnetisation and demagnetisation of the core, and to the fact that the induction is not in step during the whole period with the magnetising force, but lags behind it. The investigations of Steinmetz have shown that the hysteresis loss in iron sheets can be represented by a simple empirical formula which fits the facts fairly well. It is found that the hysteresis loss per cubic centimetre per cycle in the iron is related to the maximum value of the induction during the cycle by a simple exponential law, and may be, for all practical purposes, closely expressed by the following formulæ:—

Let H = hysteresis loss in watts per cubic centimetre,
and H^1 = hysteresis loss in watts per lb.,
then $H = \eta\,n\,B^{1{\cdot}55}\,10^{-7}$
$= {\cdot}0032\,n\,B^{1{\cdot}55}\,10^{-7}$.

Where n in the above formula is the frequency, and η is a co-efficient called the hysteretic constant, which depends upon the nature of the iron. The value of η may vary from ·002 to ·005. If we reckon the hysteresis in watts per lb., then we have

$$H_1 = 0{\cdot}88_n\,(B^1)^{1{\cdot}55}\,10^{-9},$$

where B_1 = induction per square inch.

The exponential constant may vary from 1·55 to 1·6. Thus, for example, if $n = 100$, and if B_1, the induction per square inch = 16,125, corresponding to induction per square centimetre of 2,500, then $H_1 = {\cdot}29$ watt per lb., and H = ·005 watt per cubic centimetre. These formulæ have been deduced from experiments made with various kinds of transformer iron; and although they are empirical formulæ, in the sense that they are not deduced from first principles, yet, nevertheless, they are exceedingly useful, and agree so well with experience, that they enable us to calculate the hysteresis loss at any one induction, when we know it at another. We may, therefore, put together the two expressions obtained for the eddy current loss of the hysteresis loss in iron, and state that, for all practical purposes, and within the limits of the induction usually employed in transformers, the total energy loss in the iron, made up partly of eddy current loss, and partly of hysteresis loss, may be expressed as follows:—

T = the loss per watts in cubic centimetres;
T_1 = the loss in watts per lb.; then

$$T = {\cdot}0032\,{}_nB^{1{\cdot}55}\,10^{-7} + \left(\frac{t\,{}_nB}{10^8}\right)^2.$$

$$T_1 = {\cdot}088\,n\,(B_1)^{1{\cdot}55}\,10^{-9} + \frac{1{\cdot}4}{10{\cdot}10}\,(t_1\,n\,B_1)^2.$$

Where B is the maximum induction in C.G.S. units per square centimetre, and B_1 per square inch.

The curves in fig. 25 show the variation of hysteresis and eddy current loss in plates of various thickness for a maximum value of the induction of 4,000 C.G.S. units calculated from the formulæ of Prof. J. J. Thomson.

My own experience is, that these formulæ agree very well with experience and with the results of measurement. I made some years ago a careful study of the old form of Ferranti transformers, and found a very fairly close agreement between the results of measurement of the core loss in these transformers and the results obtained by calculation from the above formulæ. In specifying for iron for use in transformers, it is now the custom to adopt a standard induction of 2,500 C.G.S. units, or lines of induction per square centimetre; that is to say, the standard induction is 25 microwebers per square centimetre—and the standard frequency is 100. Under these conditions a good transformer iron ought to have a hysteresis loss, varying from ·25 to ·5 watt per lb. It is possible, under some conditions, to get iron with less hysteresis loss than this, but, as we shall see presently, there are some difficulties in keeping it in this condition. Having selected the iron, the next thing is to stamp out the core plates, and afterwards to carefully anneal them. It is now well understood that the slightest tooling or handling of iron after it has been annealed hardens it, and raises its hysteresis loss—hence the greatest care has to be taken that the plates are not damaged after

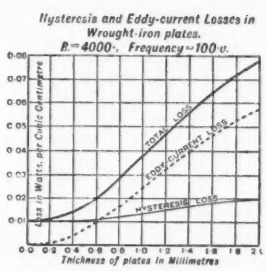
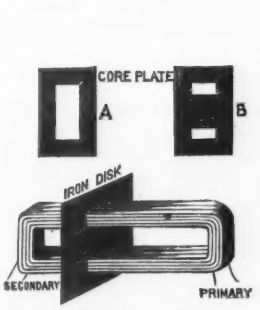


FIG. 25.

FIG. 25.

annealing. The plates have then to be insulated to keep them from electric contact with one another. The old practice was to insulate the plates with thin paper, but paper takes up too much space, and it is now usual to paint the plates with an insulating paint or varnish, which, however, must be able to withstand, without deterioration, the highest temperature which the transformer may reach in work. Even using varnish, the varnish takes about 10 per cent. of the space of the iron. In selecting the iron for the core plates, it is more important to choose an iron with small hysteresis loss than large permeability. These two things are not necessarily connected together. The number of devices which have been adopted for cutting the iron into the core plates, as to avoid unnecessary waste of metal, is very large. In fig. 26 is shown the manner of building up the core of a Mordey transformer. In fig. 27 the mode of building up a Westinghouse transformer is also shown. In this case, as in that of the Mordey transformer, where a cross piece is used, or where there are overlapping iron plates, it is customary now to use packing pieces of sheet iron to fill in the levels, and to get as much iron as possible



Mordey Transformer.
FIG. 26.

Westinghouse Transformer.
FIG. 27.

into the space. In fig. 28 is shown the method of stamping the core plates from the sheet and constructing the Scott and Addenbrooke transformer. The iron core having been constructed in such a manner as to afford a completely closed iron circuit for the lines of induction due to the magnetising force of the primary coil, the core is then covered with shellaced calico and mica, in order to insulate it from the primary coil; and the greatest care ought to be taken in this respect, because it is not sufficient to insulate the coils of the transformer from one another: they must both be insulated from the core. Thin ebonite is often used as a material for insulating the core, and an India-rubber compound called woodite is a very good material to use. The primary and secondary coils are generally wound on formers; they must be insulated from each other by ebonite or mica, and the primary and secondary coils should be so overlayed or intermingled (as shown in fig. 29, which represents a typical closed iron current transformer) to avoid producing magnetic leakage. In large transformers it is customary to leave a space between the high and low tension coils for the purpose of ventilation, and in the same way air spaces or ventilation spaces have to be left in the iron core. The primary and secondary coils are sometimes separated from one another by a metal shielding plate, which is connected to earth. This is, however, not so good a plan as an effectual separation of the

primary and secondary coils by an insulating shield. In the design of the core it is important to reduce the reluctance of the magnetic circuit as much as possible, in order to produce a large power factor. The term "power factor" is defined as a number representing the ratio between the true power taken up in the core to the product of the primary potential difference and the primary current (root-mean-square values being understood). This product is called the *apparent power* taken up in the core.

We shall consider in a later lecture the disadvantages of a small-power factor. Meanwhile, it may be said that a small-power factor in a transformer, when taken at no secondary load, is always an indication of large magnetic reluctance in the magnetic circuit, and hence open iron circuit transformers have always small-power factors. The primary and secondary coils, having been placed upon the core and insulated from one another, the transformer is put into an iron case, which is constructed to be watertight. Many manufacturers include in the same case porcelain plates or terminals, to which they attach the extremities of the primary and secondary coils. This, however, is not so good a plan as connecting by a highly insulated joint the extremities of the primary and secondary coils to highly insulated cables, which are brought out through watertight glands in the iron case, any necessary connections to fuses or switches being

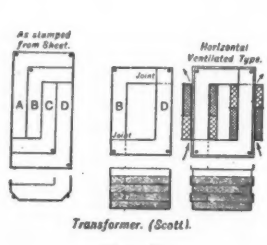


FIG. 28.

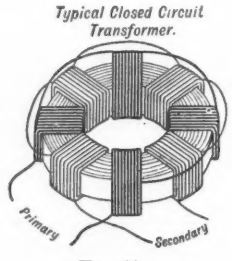


FIG. 29.

then made outside. In the design of large transformers, one important consideration is getting rid of the heat. A transformer ought never to rise above 100° Centigrade under any conditions of use, and for every watt which is lost in hysteresis, and by copper resistance at least 3 to 4 square inches of cooling surfaces must be provided. In the case of very large sub-station transformers, it has even been found advantageous not only to leave ventilating spaces in the core, but to force a draught of air through the transformer to keep it cool. In some cases a highly insulating oil is put into the case, but the insulation of the transformer must be good enough to work without it. The use of the oil is merely to keep out damp air, and even then it is not always successful in preventing break down. The notion that oil could be used as an insulation for transformers, which would heal up again after the passage of a spark or arc, was not confirmed by experience. As regards the general design of transformers, the battle

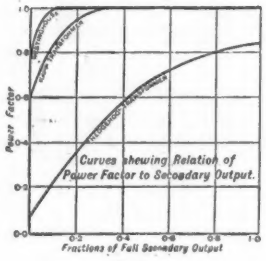


FIG. 30.

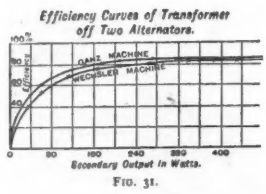


FIG. 31.

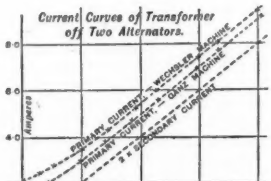
of open *versus* closed iron circuit transformers was fought out and decided long ago. Open circuit transformers—such as the Hedgehog transformer—have no advantage over the closed iron circuit transformer in respect of core loss per kilowatt output, and they have a decided disadvantage in a smaller power factor. Moreover, in a closed iron circuit transformer, as the transformer is loaded up, the power factor very soon reaches unity; the curves in fig. 30 show the manner in which the power factor of several different types of transformer varies as the transformer is loaded up. In a good closed iron circuit transformer, with small magnetic reluctance, a very little loading of the secondary circuit brings the power factor up to unity. In the case of a 6 kilowatt Mordey transformer I found that, loading up to $\frac{1}{10}$th of full load, brings the power factor up to unity. The advantage of large power factor means that we have a small root-mean-square value in the magnetising current at no load, and, therefore, a small heating loss in the main supplying the current of that transformer. When the transformer is at work we not only have energy losses going on in the iron, but, at the same time, we have energy losses in the copper, called the copper losses, which are due to the resistance of the copper circuit. It can be shown the most advantageous ratio between the copper losses and the iron losses is to so construct the transformer that at full load the total copper losses are equal to the total iron losses. In very large transformers, where the secondary circuit consists of very thick copper bands or wire, if magnetic leakage exists to any sensible extent, we may have eddy current losses set up in the copper circuits, and this, in addition, may be a source of energy waste. The copper resistance operates not only to cause a large energy loss, but partly to account for what is called the secondary drop of the transformer. If a transformer is connected to a constant potential primary circuit, and if the secondary circuit is gradually loaded up, the potential difference between the secondary terminals is less when the transformer is fully loaded than it is when the transformer is on open secondary circuit. This difference is called the secondary drop. This drop is due to three causes—firstly, the resistance of the primary circuit; secondly, the resistance of the secondary circuit; and, thirdly, to magnetic leakage. As far as regards the copper resistance, we may calculate the secondary drop by the following formula:—

$$\text{Secondary drop} = \frac{100 \times (C_1 - \textit{mag. cur.})\, R_1}{E_1} + \frac{100\, C_2\, R_2}{E_2},$$

Where C_1 is the R.M.S. of the primary current.
C_2 is the same value for the secondary current.
R_1 is the resistance of the primary circuit.
R_2 is the resistance of the secondary circuit.
E_1 is the difference of potential between the primary terminals.
E_2 is the difference of potential between the secondary terminals

taken when the transformer is on open secondary circuit, and the symbol *mag. cur.* stands for the magnetising current of the transformer, that is, the primary current when the transformer is on open secondary circuit.

FIG. 32.


Current Curves of Transformer off Two Alternators.
Amperes
PRIMARY CURRENT - WECHSLER MACHINE
PRIMARY CURRENT - GANZ MACHINE
SECONDARY CURRENT
Secondary Current in Amperes

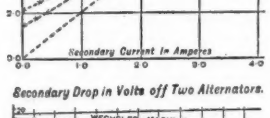


FIG. 33.

This formula, however, only gives us that part of the drop which is due to the copper resistances; the actual observed drop would be greater than this by an amount due to magnetic leakage.

In dealing with the testing of transformers in our next lecture, we shall discuss the method by which this drop may be measured. In considering the action of transformers, it is important to notice that the iron core loss of the transformer, the secondary drop, and the power factor of the transformer at no load, are all greatly affected by the form of the curve of primary electromotive force. It is the custom sometimes to speak of the core loss of a transformer as if it were a quantity inherent in the transformer itself, and which could be exactly specified for any particular instrument. As a matter of fact, this is not the case. Experiments carried out with different transformers worked on different alternators by Dr. Roessler in Germany, and by myself in England, have abundantly demonstrated that the form of the curve of primary electromotive force has an immense influence on all the above-mentioned quantities. Dr. Roessler employed two machines—one a Wechsler and the other a Ganz alternator. When these machines were running on open circuit, the Wechsler alternator gives a curve of electromotive force which has a well-rounded form; whereas the Ganz machine has a curve of electromotive force which has a very sharp or peaked form. The machines I chiefly employed in my own experiments were the Mordey alternator, the Thomson-Houston alternator and a Ferranti machine. The form of the curves of electromotive force of the first two named machines, under various conditions, have been shown in Lecture I. The general effect of all these experiments has been to demonstrate that when a transformer is worked off an alternator giving an electromotive force curve with a very sharp or peaked form, the effect of this is to make the iron core loss *less*, and the secondary drop *greater* than it is if the same transformer is worked off an alternator having a curve of electromotive force with a rounded or square-shouldered form. If, therefore, we draw an efficiency curve for a transformer, that efficiency curve giving the efficiency—that is to say, the ratio between the watts delivered from the secondary to the watts taken in on the transformer circuit—and express this efficiency in terms of the fractions of the secondary load of the transformer, the form of that efficiency curve will be affected by the nature of the machine which is supplying the primary current. In figs. 31, 32, 33, are shown curves illustrating the effect of the employment of different alter-

nators on the same transformer in affecting the efficiency, primary current values and secondary drop of any given transformer, when taken on open secondary circuit.

For fuller information on this point the reader is referred to the treatise on the "Alternate Current Transformer" * (Vol. I., Chap. vi., new edition) by the present writer, which will supply more details on this question than we have space to consider here.

THE CITY AND GUILDS OF LONDON TECHNICAL INSTITUTE.

The short history of the City and Guilds of London Institute for the advancement of technical education, which has recently been issued, is an interesting document as showing the progress which the institute has made since its foundation in 1878.

A Provisional Committee in 1877 recommended—firstly, the establishment of a central institution or college for the advanced education of those who had already acquired a sufficient knowledge of science or the arts to enable them to profit by instruction in the industrial applications of these; secondly the conducting of examinations in technological subjects; and thirdly the encouragement of the establishment of local schools for artizans and workmen, and of the co-operation with and the assistance of local effort, more especially, but not exclusively, within the Metropolis. Up to that time no serious effort had been made in this country to provide instruction in the application of science and the arts to industrial processes, although, both on the Continent and in America, well-organised and equipped colleges, with similar functions to those of the proposed Central College, had been in active operation for several years; some of the principal being:—The Ecole Centrale des Arts et Manufactures, of Paris, founded in 1829; the Technical High Schools of Munich, Hanover, Karlsruhe, Stuttgart, and other towns in Germany (that of Berlin was founded in 1879) and of Vienna in Austria; the Ecole Polytechnique Fédérale, of Zurich, in Switzerland, founded in 1855; and the Massachusetts Institute of Technology in America founded in 1861.

The proposals of the Provisional Committee met with the approval of the Corporation and the Livery Companies, and the City and Guilds of London Institute for the Advancement of Technical Education was founded in 1878, and incorporated in 1880.

The practical value of the training provided in the Central Technical College is shown by the responsible positions to which many past students have already attained in their respective industries, or in professional capacities. The first complete courses of instruction commenced in January, 1885, and terminated in July, 1887. The following table gives the number of students in attendance each session, together with the number of occasional students attending short courses of lectures only, special courses given in the evening and on Saturdays, and the School of Art Wood Carving, which, although not directly under the management of the Institute, is granted free use of rooms in the College.

Central Technical College.

Session.	Day students.	Occasional and evening students.
1885	6	227
1885—6	35	415
1886—7	76	634
1887—8	122	493
1888—9	124	481
1889—90	153	454
1890—1	166	496
1891—2	184	478
1892—3	205	446
1893—4	222	438
1894—5	208	526

The fees and other charges received from students of the Central Technical College amount to about £5,000 annually, exclusive of about £500 remitted in the form of scholarships, or upon special application by candidates whose parents are not in a position to pay the full fees.

The progress of the Technical College, Finsbury, which grew out of a few evening classes started in 1878 in the basement of the Middle Class Schools in Cowper Street, is shown by the following table.

The fees and other charges received from students amount to over £3,000 annually, exclusive of about £350 remitted in the form of studentships or on special application.

A very important part of the Institute's work consists of the "Technological Examinations." These examinations have become a powerful agency in encouraging the establishment of technical schools and classes throughout the country, in assisting County Councils and other bodies in the organisation of their local schools and classes, and in securing the useful expenditure of the grants placed at their disposal under the Local Taxation Act, 1890. Syllabuses of instruction in some sixty subjects, suitable for artizans, apprentices, and others attending evening classes, have been prepared, and are carefully revised every year by competent men practically acquainted with their respective industries; examinations are held at the close of each session in May; certificates and prizes being awarded on the results. The Institute also reports on the efficiency of the instruction as shown by the results of these examinations; inspects schools and classes, and advises the County Councils and other local bodies on the equipment of the schools, the efficiency of the teachers, and the suitability of the instruction to the requirements of local industries. Apart from the examinations, which, in 1895, were held in 353 centres in the United Kingdom, Sydney, Wellington, Pietermaritzburg, and Bombay, special inspections have been undertaken at the request of the Surrey, Essex, Kent, Hampshire, Devonshire, and Yorkshire (West Riding) County Councils.

The steady growth of these examinations is shown in the following tables, the first dealing with technological subjects for artizans and apprentices, and the second with the examinations qualifying teachers in elementary and other schools in manual training, woodwork, and metalwork:—

Technical College, Finsbury.

Session.	Day Students.	Evening Students.
1882—3	100	746
1883—4	109	685
1884—5	158	612
1885—6	169	764
1886—7	156	912
1887—8	163	1,054
1888—9	169	927
1889—90	180	972
1890—1	185	1,087
1891—2	198	1,017
1892—3	213	930
1893—4	197	922
1894—5	210	926

Technological Examinations.

Year.	Number of centres.	Number of classes.	Number of students in attendance.	Number of candidates' papers.
1879	23	...	...	202
1880	89	...	...	816
1881	78	...	2,500	1,563
1882	147	...	3,467	1,972
1883	154	...	4,052	2,397
1884	164	...	5,874	3,635
1885	167	263	6,396	3,968
1886	192	329	7,660	4,764
1887	216	365	8,613	5,508
1888	240	475	10,404	6,166
1889	231	520	11,874	6,448
1890	219	483	12,022	6,667
1891	245	519	13,202	7,416
1892	265	610	16,565	8,534
1893	288	689	22,621	9,179
1894	346	701	22,703	9,907
1895	353	739	24,920	10,293

Manual Training Examinations.

Year.	Candidates in woodwork.	Candidates in metalwork.	Total.
1892	615	...	615
1893	1,141	...	1,141
1894	1,766	50	1,816
1895	1,543	59	1,602

The South London Technical Art School, the Leather Trades' School, founded by the Institute, have also been very successful.

As regards finance, the total amount subscribed by the companies during the past 18 years is, in round figures, £480,000, of which £150,000 has been expended on buildings and equipment, and the remainder on maintenance, scholarships, prizes, and grants-in-aid. The cost of the several branches of the Institute's work for 1895 is

* "The Alternate Current Transformer in Theory and Practice." 2 vols. The *Electrician* Printing and Publishing Company, 1, Salisbury Court, Fleet Street.

given in the following table, together with the income derived from fees and from sources other than the City and its companies.

	Cost.	Receipts other than from City and Guilds.	Net cost.
	£	£	£
Central Technical College ...	11,683*	4,993	6,690
Technical College, Finsbury ...	9,551	3,225	6,326
South London Technical Art School	1,173	95	1,078
Technological examinations, including prizes £415	6,133	1,600	4,533
Leather Trades School	1,037†	66	971
Grants in aid	625	—	625
Fellowship and scholarships ...	1,026	428	598
Administration	1,087	70	1,017
	£32,315	£10,477	£21,838

* Exclusive of £206 for apparatus purchased out of the Special Equipment Fund provided in 1890.

† Including special grants from the Leathersellers' (£250), Cordwainers' (£100), and Skinners' (£21) Companies.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

NEW PATENTS.—1896.

15,447. "A brush holder to be used on dynamos and motors." G. E. Francis. Dated July 13th.

15,479. "Improvements in submarine cable laying appliances." C. Snell. Dated July 13th.

15,495. "Improvements in battery lamps." W. Morrison. Dated July 13th.

15,517. "Improvements in electric batteries." R. Sauerwald and H. Grune. Dated July 13th.

15,595. "An improved electricity meter for registering the amount of current consumed on direct or alternating polyphase, triphase, or quadruplephase circuits." F. J. Beaumont and F. Hallows. Dated July 14th.

15,606. "Improvements in printing telegraphy." J. J. Reiffgraber. Dated July 14th.

15,614. "Improvements in electrical relays." W. S. Smith and W. P. Granville. Dated July 14th.

15,677. "An improved electrical counter." J. G. Dixon. Dated July 15th.

15,678. "Method and apparatus for utilising the mechanism of existing wind-mills for generating and storing electricity." F. Gray. Dated July 15th.

15,696. "Improvements in the manufacture of tubes by electro-deposition." E. Casper. Dated July 15th.

15,704. "Improvements connected with joint or like boxes and appliances or attachments to be used therewith for electric and like wires." C. N. Russell. Dated July 15th.

15,768. "An improved electro-magnetic brake for vehicles." H. H. Lake. (Union Elektricitäts-Gesellschaft, Germany.) Dated July 16th.

15,777. "Improvements in electrically actuated vehicle wheels." C. Theryc. Dated July 16th. (Date applied for under Patents, &c., Act, 1883, Section 103, January 30th, 1896, being date of application in France.)

15,782. "Improvements in or relating to electric railways." A. H. Brintnell and G. S. Baker. Dated July 16th.

15,834. "Improvements relating to the electrolysis of soluble salts especially applicable for the production of chlorine." A. J. Outhenin-Chalandre. Dated July 17th.

15,837. "Improvements in electric apparatus for striking a bell, bells, or the like, or producing other effects by means of and at a distance from a clock." E. R. Dale. Dated July 17th.

15,966. "Improvements in or relating to electric arc lamps. H. Leitner. Dated July 18th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free, 8½d. (in stamps.)*]

1895.

7,152. "Improvements in the mode of and means for writing by telegraphy." J. V. Faber. Dated April 8th, 1895. This apparatus is characterised by the motion of a pencil which is converted into two motions, drawn or formed as polar co-ordinates which are singly or separately transmitted to the receiving station, and reconverted or reconstituted these into one resultant which reproduces the original motion of the pencil at the receiving station. 4 claims.

8,583. "Improvements in and connected with electric block signalling apparatus for railways." A. Berry and J. Lipkowski. Dated April 30th, 1895. [Date applied for under Patents, &c., Act, 1883, Sec. 103, October 30th, 1894, being date of application in France.] Relates to a combination of various devices so arranged as to (1) indicate on boards put up at the "departure" and "arrival" stations in what section of the line a tram travelling between two stations happens to be at the time. (2) Record on boards at the meeting points of adjacent sections of the line, the presence of a train on either section (*i.e.*, either "up" or "down" section), the signal being given at both ends of the section within which the train happens to be at the time. (3) Automatically prevent two trains from travelling on one section of the line at the same time. (4) Electrically transmit various signals to the engine driver by means of an indicator on the engine. (5) Electrically to connect a train in motion with the station and section instruments, or even with another train through the medium of those instruments and of others arranged upon the line. 6 claims.

9,546. "Improvements in or relating to conduits, conductors, and collectors for electric railways." E. Lachmann. Dated May 14th, 1896. Means are described whereby water that may accumulate in the conduit is prevented from reaching the conductor. Further objects of the invention consist in the improvement of the construction of the water line conductor; in the construction of the contact carrying devices and switches, and in the means for keeping one of the track rails as well as the conduit free from obstruction and dust and dirt. 24 claims.

10,448. "Improvements in secondary or storage batteries." L. Falero and H. Lumley. Dated May 27th, 1895. The electrodes consist of a inter receptacle of aluminium or its alloys in the form of gauze tulle, or perforated sheets charged with active material and provided with one or more internal conductors, also of aluminium, or its alloys, either moulded or in any of the above forms. 6 claims.

10,614. "Improvements in or relating to electric telephone systems." T. Sloper and G. E. Beckett. Dated May 29th, 1895. Describes a telephone system having separate lines appertaining to each station, a return or earth line, and a special reply line, the whole being so arranged that the reply line may be temporarily used for conversation between any two stations and that a circuit may be afterwards formed through the two lines appertaining to the two speaking stations. Various other arrangements are also described, and reference is made to Patent 13,367, of 1891. 6 claims.

10,655. "Improvements in and connected with electric arc lamps." G. Binswanger and A. E. Angold. Dated May 29th, 1895. Claims the combination of a rocking frame and an upper frame carrying a composite wheel and also a satchet and brake periphery, and a sprocket or chain wheel and its chain, with a brake block, saddle pin and pawl. Means are also described for sustaining the weight of a composite wheel with the suspensory chain upon either the brake block, the pawl, or the saddle pin, so as to produce the requisite striking and feeding movement. 3 claims.

10,687. "Improvements in the arc striking and feeding devices and arc lamp frames for arc lamps, more especially applicable to those arc lamps used singly, or two or more in series across incandescent or constant potential mains." F. D. A. Goold. Dated May 30th, 1895. Relates to an arc lamp in which a high resistance fine wire coil instead of the usual thick wire, for striking the arc, is connected directly across the mains, which controls devices for separating the carbons. A high resistance shunt coil operates to release the feeding devices, and to break the shunt circuit through a detent in the escapement. 3 claims.

11,016. "Improvements in electrolytic decompositions, and especially in the electrolytic production of bleaching agents and their uses, and in electrodes and apparatus therefor." H. Blackman. Dated June 4th, 1895. Comprises a contumacious electrolytic bleaching process, consisting in first electrolysing a solution of a chloride of an alkali by circulating it through an electrolyser, heating the electrolyte containing the resulting hypochlorite bleaching with it while at an elevated temperature continually drawing off the electrolyte from the material being bleached, cooling it, and returning it to the electrolyte. 12 claims.

11,032. "Improvements in secondary batteries or accumulators." Theodor Eremin. Dated June 4th, 1895. This patent relates to an electric accumulator characterised by arranging the positive and negative plates shaped as frames, filled with active material and wrapped in asbestos paper, parchment, or other material, in the common vessel, in such a manner that the spaces between the adjacent plates and the latter and the walls are filled with broken glass, small hollow, glass globes, coarse sand or other material indifferent to the chemical reactions which take place in the accumulator. 1 claim.

11,181. "Improvements in switching apparatus for electric currents." H. Edmunds. Dated June 6th, 1895. Describes a switching apparatus whereby electric circuits can be completed and interrupted so that when one is completed a second is interrupted, when the first is interrupted the second is completed, so that the second circuit can thereafter be interrupted by momentarily completing the first circuit in the first direction. 4 claims.

19,304. "Improvements in and apparatus for producing electric light." W. H. Wise. (The Moore Electrical Company.) Dated October 15th, 1895. Consists in setting up electric waves or pulsations suitable for producing luminous effects by repeatedly interrupting electrically or mechanically a circuit of induction in a high—as distinguished from a partial—vacuum, and utilising the electric energy so generated as to produce luminous effects by action in or upon a receiver containing a gas so rarefied that the whole body of contained gas will be rendered luminous. 7 claims.